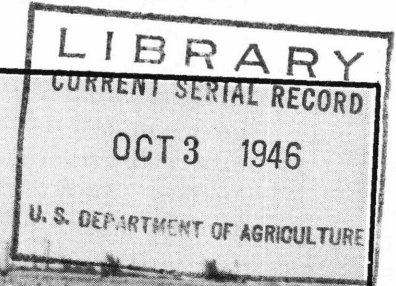


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GROWING and FEEDING GRAIN SORGHUMS



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GRAIN SORGHUMS were introduced into the United States from Africa and Asia. They are best adapted to the semiarid sections of Texas, Oklahoma, Kansas, and adjacent States; and to the hot, dry, irrigated valleys of the Southwest. They are grown mostly in the southern half of the Great Plains where the average annual precipitation is 17 to 25 inches. About 100 million bushels are grown annually in the United States.

More than 40 varieties of grain sorghum are grown in this country. Blackhull kafir is the leading variety in the eastern portion of the grain-sorghum region, but Dwarf Yellow milo leads in the West. Hegari is highly regarded as a bundle feed because of its leafy, palatable stalks. The varieties differ in their suitability for forage as well as in grain production and adaptation to various conditions. Several short-stalked varieties can be harvested satisfactorily with a combine or a grain header.

Grain sorghums usually succeed best when planted between May 15 and July 1 in a well-prepared warm seedbed in rows about 3½ feet apart at the rate of 2 to 5 pounds of seed per acre. The seed should be treated before being planted with a dust fungicide that controls smut and reduces seed rotting.

Grain sorghum is fed to all classes of livestock. Its feeding value is slightly less than that of corn. It is desirable to grind the grain if it is to be fed to any livestock except poultry and sheep. Grain sorghum shipped to market is largely fed to poultry or used in ground mixed feeds.

GROWING AND FEEDING GRAIN SORGHUMS

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THE GRAIN SORGHUM CROP

FOUR DIFFERENT TYPES of sorghums (*Sorghum vulgare* Pers.) are grown in the United States. These are (1) grain sorghums, including kafir, milo, feterita, etc.; (2) sorgos (sweet or saccharine sorghums) used as forage and for sirup making; (3) broomcorn; and (4) grass sorghums (Sudan grass).¹

Grain sorghums have been known in Asia and Africa for hundreds of years and are the principal grain crops in some parts of those continents. A few varieties of grain sorghums were introduced into the United States and grown during the colonial period, but the crop did not become permanently established then. Grain sorghums have been grown continuously in this country since 1874, but numerous introductions have been made during the past half century. The crop began to assume some importance in Kansas during the eighties, and the production in Kansas and other Southwestern States increased rapidly up to the period of the World War. The superior drought

¹ For information on sorghums other than grain sorghums see U. S. Department of Agriculture Farmers' Bulletins 1158, Growing and Utilizing Sorghums for Forage; 1619, Sorgo for Sirup Production: Culture, Harvesting, and Handling; 1126, Sudan Grass; and 1631, Broomcorn Growing and Handling.

resistance of grain sorghums has been largely responsible for their popularity. At present grain sorghums are a staple feed-grain crop not only in the semiarid portion of the Southwest but in the hot, dry, irrigated valleys of southern Arizona and California. Ordinarily, more than 100 million bushels, valued at 20 to 70 million dollars, are grown annually in the United States.

The leading States in the production of grain sorghums and the average acreage during the 5-year period 1929-33 were: Texas, 3,703,000; Oklahoma, 1,433,000; Kansas, 1,224,000; New Mexico, 324,000; Colorado, 213,000; California, 95,000; Missouri, 87,000; Arizona, 34,000; and Nebraska, 22,000. The distribution of the grain sorghums in 1929, according to the United States census, is shown in figure 1.

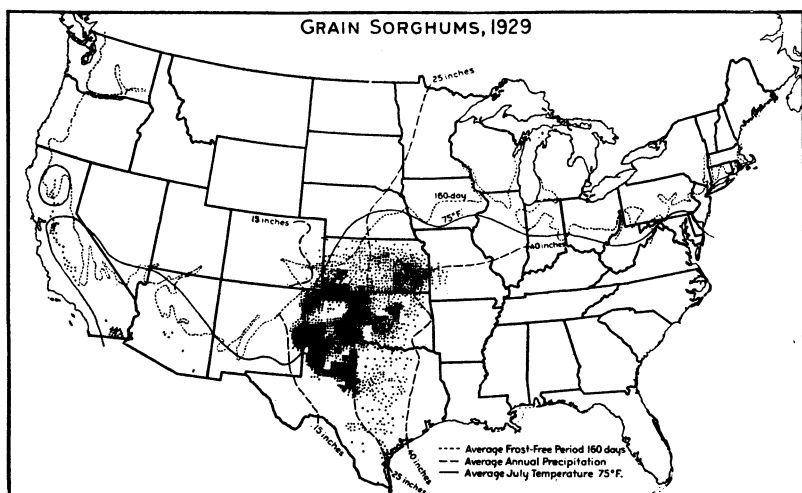


FIGURE 1.—Distribution of grain sorghums in 1929. Each dot represents 1,000 acres.

ADAPTATION OF GRAIN SORGHUMS

Grain sorghums are best adapted, in general, to the section of production shown by the dots on the map in figure 1. The chief factors determining their adaptation are moisture, temperature, insects, and soil type. They are drought-resistant and well adapted to regions of limited rainfall, but they also will grow well where moisture is abundant. Extremely wet weather at harvesttime may cause the heads to mold. Other crops such as corn also usually outyield grain sorghums under humid conditions, and consequently the latter are grown mostly where the average annual precipitation is only 17 to 25 inches (fig. 1). In parts of southeastern Kansas and southwestern Missouri, which have a rainfall greater than 30 inches, where grain sorghums outyield corn, the soils are shallow and cannot retain sufficient moisture for a good corn crop. In some parts of Kansas and Oklahoma farmers often grow corn on the bottom lands and grain sorghums on the uplands, where moisture is likely to be limited.

Although superior to other crops in their ability to produce grain with a limited supply of moisture, grain sorghums frequently fail

to produce a crop because of extreme drought. Sorghum plants often remain dormant during periods of drought, and consequently rains must come in time to develop heads and grain before frost occurs. Some forage usually is produced, however, even in the driest seasons.

Grain sorghums are of tropical origin and, therefore, grow best where the season is warm. The plants require a warm seedbed for the best germination and early growth. Soil temperatures of 70° F., or higher, give the best germination and seedling growth. Cool summer weather retards growth and may prevent seed formation. The plants are killed easily by frost.

Grain sorghums are grown in the United States very largely in sections having an average frost-free period of 5 months or more and an average July temperature of about 75° F. or higher (fig. 1). In sections having shorter or cooler seasons the crop is grown chiefly for forage, as grain production is too uncertain. The growing season of the numerous varieties of grain sorghums ranges from 80 to 140 days under favorable conditions. Early planted sorghums usually require a longer period from planting to maturity than those planted later. The soil or weather usually is too cool for the best growth of sorghums at the beginning and end of the frost-free period; hence only a part of this period is available for producing a crop.

The sorghum plant seems to withstand extreme heat better than other grain crops. Apparently little injury occurs as a result of the very high temperatures that often prevail in the irrigated valleys of southern California and Arizona. Better yields are obtained, however, when the plants come into head after the period of greatest heat is past.

At the eastern border of the important grain sorghum region the crop is restricted chiefly by chinch bugs (*Blissus leucopterus* Say). These insects injure nearly all varieties of grain sorghum in eastern Kansas and Oklahoma and almost prohibit the growing of milo. In southern Texas and other Gulf States the sorghum midge (*Contarinia sorghicola* Coq.) largely prevents the extensive growing of sorghums for grain by destroying the developing seeds in the heads.

Grain sorghums are grown successfully on all types of soil, but in dry seasons they do best on sandy soils. Heavy soils ("hard lands") produce good grain sorghum crops in wet seasons, but the plants are likely to suffer from drought in dry seasons. Heavy soils are much better suited to wheat production than are light, sandy soils, and in many sections the former are devoted to wheat and the latter to sorghums. Sorghums are among the crops that will tolerate considerable quantities of alkali, or salts, fairly well.

The soils in many parts of the Southwest where cotton is grown have become infested with Texas root rot (*Phymatotrichum omnivorum* Shear) Duggar. This disease injures numerous taprooted plants such as cotton, alfalfa, cowpeas, melons, and fruit trees but rarely attacks fibrous-rooted plants such as sorghums and small grains. Hence, fields badly infested with the root rot organism can often be planted to grain sorghums to advantage. This practice is followed to some extent in Arizona.

VARIETIES

More than 40 distinct varieties of grain sorghums are now grown in the United States. Some of these are shown in figure 2. Many of the older, well-known varieties are grouped as kafir, milo, feterita, durra, hegari, shallu, and kaoliang, but in addition there are several miscellaneous varieties of hybrid origin, including darso, Shrock, Freed, White Yolo, Chiltex, and Premo, which do not admit of easy classification. New, untested varieties developed by farmers from natural hybrids are exploited from time to time; some of the most recent of these are "Manko maize", "Irish maize", and Grohoma.

The varieties differ in time of maturity, height, juiciness of stalk, size and color of grain, leafiness, color of chaff, beardedness, shape and compactness of heads, and many other characters. The extremely early varieties are used mostly for late planting or in districts having short seasons or a limited moisture supply. Some varieties normally reach heights of more than 6 feet, but extra-dwarf varieties grown for harvesting with combines usually do not exceed 2½ feet in height.

KAFIR

The typical kafirs have juicy, but not sweet, stalks; long, slender, cylindrical heads; and small white, pink, or red seeds. The plants usually have few suckers. The heads, except those of Bishop kafir, are beardless. Wonder kafir, which is of hybrid origin, has dry stalks; and Pink kafir, as usually grown, is a mixture of dry and juicy stalks. Kafir is grown to a considerable extent for forage on account of its leafy, juicy stalks.

The kafirs vary in average height from about 4 to 7 feet and usually do not lodge until after frost or late in the season. They are very susceptible to kernel smut but fairly resistant to chinch bug injury and thus can be grown farther east than the milos.

The leading variety of kafir is the ordinary Blackhull (figs. 2 and 3). Several strains of this variety vary chiefly in time of maturity and height. Other varieties are Red, Pink, Dawn, Dwarf, Reed, Sunrise, Bishop, Wonder, White, Rice, and Pearl.

Standard Blackhull kafir is the leading variety in the eastern half of Kansas, Oklahoma, and Texas, and in southwestern Missouri. Earlier and shorter strains such as Texas Blackhull and Western Blackhull are better suited to the western parts of Kansas, Oklahoma, and Texas. The Blackhull variety has white seeds which, before being threshed, are partly covered with black hulls or chaff.

The most common strain of Red kafir (fig. 2) is tall and late, and has long, slender heads. It is a good variety for forage but, because of its late maturity, produces high yields of grain only under very favorable conditions. Early-maturing strains, of which there are several, are to be preferred on poor soil or in areas of limited moisture. Some of these are not so juicy and hence not so desirable for forage as the better-known, late-maturing strains.

Pink kafir, a medium early variety with pink seeds and long, slender heads, is grown in southern and western Kansas chiefly for forage to be fed as "bundle feed." Dawn kafir is early and short and best suited to conditions of limited moisture or to short seasons under

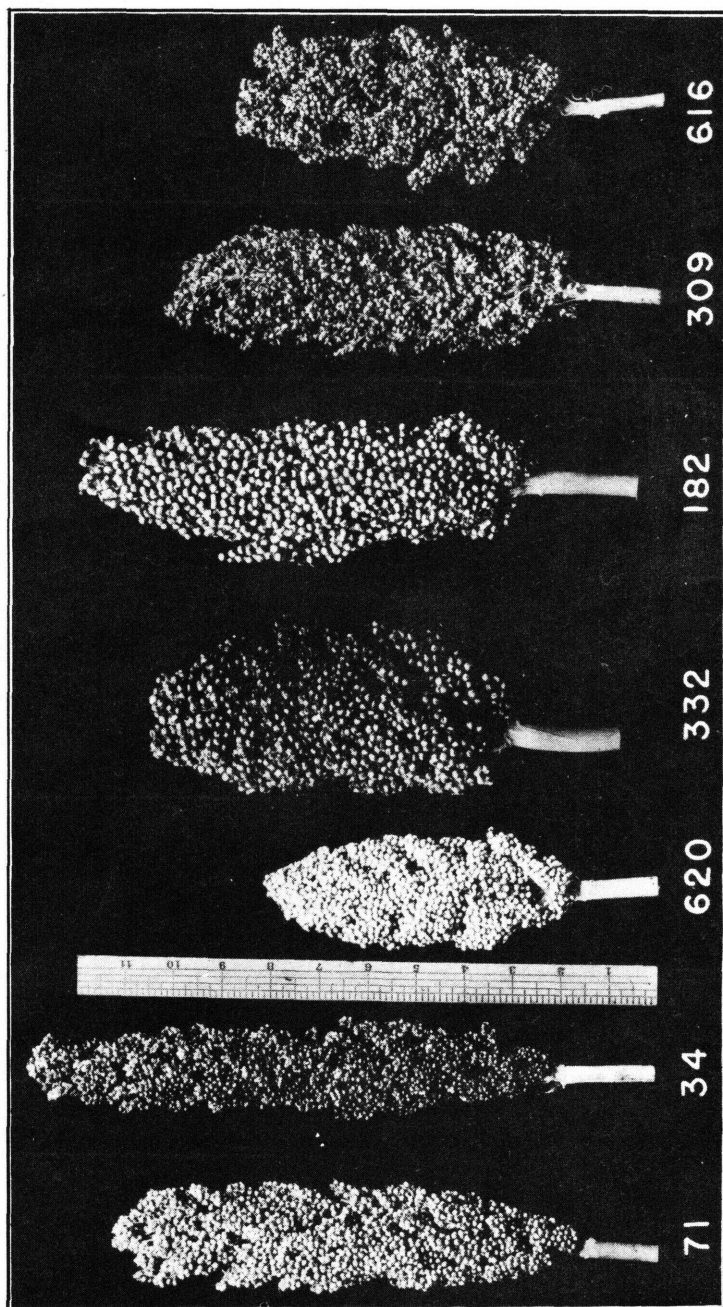


FIGURE 2.—Heads of leading varieties of grain sorghums. 71, Blackhull kafir; 34, Red kafir; 620, Dwarf Yellow milo; 182, feterita; 309, darso; and 616, Schrock (Sagrain).

which other varieties are likely to fail to produce grain. Sunrise is similar to Dawn except that it is taller and has sweeter stalks and suckers more abundantly. Sunrise is a good variety to grow for bundle feed in the western part of the Great Plains because of its tall, slender, sweet, and numerous stalks and its early maturity. The name "Dwarf kafir" is sometimes used for the Dawn variety, but other strains of Dwarf kafir are very similar to the Western Blackhull and Texas Blackhull varieties. Reed kafir has long, black glumes; it produces good yields of grain in many sections of the Great Plains but is of limited value for forage because of its brittle leaves and infrequent tillering. It also lodges easily. Hydro kafir is similar to Reed except in being later and in having thicker heads. Bishop kafir, also called Algeria, has large bushy heads, is rather late in



FIGURE 3.—A field of Blackhull kafir.

maturing, and is susceptible to chinch bug injury. It is promising only under conditions of ample moisture favorable for high yields. Wonder kafir is rather early and of striking appearance but is susceptible to seed rots much as are the feteritas. White kafir, now grown only sparingly, is similar to Blackhull except that it has white chaff on the seeds and drier stalks and is earlier than the Standard Blackhull. Rice and Pearl have white seeds and black chaff. They are seldom grown.

MILO

The milos have slightly juicy stalks, compact, bearded heads (except the Fargo and Wheatland varieties), and rather large yellow or white and rather soft seeds. All varieties, with the exception of Beaver, Wheatland, and Fargo, which are hybrids with kafir, have a strong tendency to produce recurved or goosenecked heads. The milos sucker freely. The fully developed leaves show a distinctly yellow midvein or midrib.

The milos in general are resistant to some forms of covered kernel smut and susceptible to others. The Fargo variety is susceptible to the ordinary kafir smut, but other milos are resistant. Smut damage in the latter usually is not serious. All milos are extremely susceptible to chinch bug injury and should not be grown where these insects are prevalent. They also are very susceptible to a recently discovered but destructive root and stalk rot.

The milos are very adaptable to variations in soil-moisture supply. They nearly always yield some grain under drought conditions, being superior to kafir in this respect. The milos also can produce extremely large yields of grain under favorable conditions of moisture, tempera-

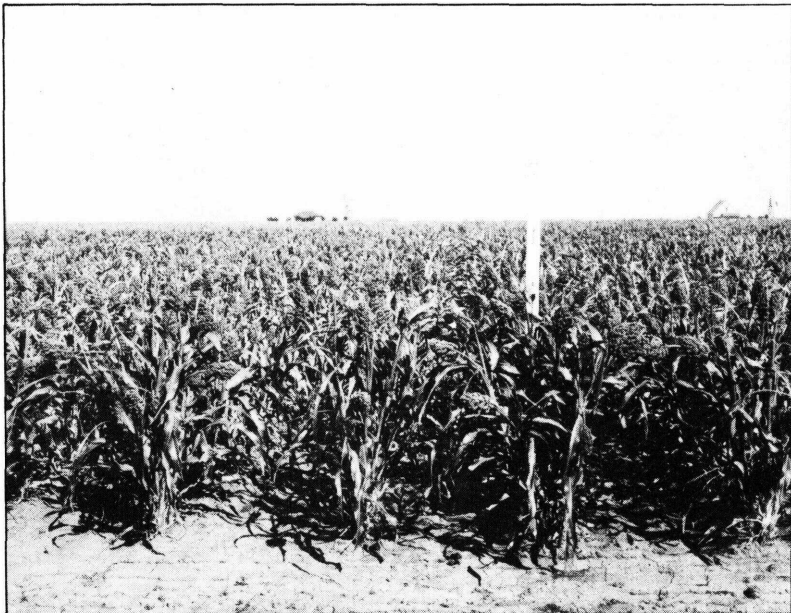


FIGURE 4.—A field of Dwarf Yellow milo.

ture, and soil. The suckering ability of milo enables it to adjust itself to the row space or moisture supply much more readily than most kafir varieties.

The varieties of milo grown in the United States are Dwarf Yellow, Standard Yellow, Double Dwarf, Fargo (Straightneck), Beaver, Wheatland, Sooner (Sixty Day), Early White (Sugar), Dwarf White, Standard White, Desert "maize", and Desert Bishop. The last five varieties are white-seeded and are grown rather infrequently. The others have yellow seeds. All varieties mature in approximately the same period, with the exception of Sooner and Early White, which are earlier, and Fargo, which is later than the others. The milos in general are somewhat earlier than the kafirs, requiring 100 to 130 days to reach maturity.

Dwarf Yellow milo (figs. 2 and 4) rank second in importance to Blackhull kafir among the grain sorghum varieties. It is the highest-yielding variety of the milos under most conditions and is widely

adapted. It ranges from 2 to 6 feet in height, averaging about 3½ feet. The Dwarf White variety is nearly identical with Dwarf Yellow except in seed color.

The Standard Yellow and Standard White varieties usually are 1 to 2 feet taller than the Dwarf Yellow grown under the same conditions. They are grown only sparingly because they are harder to harvest and are not superior to the Dwarf Yellow variety.

Fargo (Straightneck), Desert "maize", and Desert Bishop are slightly shorter than Standard Yellow milo. Fargo is a productive variety in southern Arizona.

Double Dwarf, Beaver, and Wheatland usually stand only 1½ to 3 feet in height and are grown chiefly because of their suitability to harvesting with a combine. Wheatland and Beaver have erect heads



FIGURE 5.—A field of feterita.

and resist lodging much better than other milos. They were bred by the United States Department of Agriculture particularly for machine harvesting and are now grown on several hundred thousand acres.

FETERITA

The feteritas have dry stalks, erect, rather compact, oval heads, and very large chalky-white, soft seeds. Feterita is less leafy than kafir or milo (figs. 2 and 5). The seeds are larger than those of milo and slightly flattened, and the seed coats are covered with small lines or checks. The heads are beardless. The plants as a rule sucker less than those of milo but more than nearly all varieties of kafir. Feterita is generally resistant to smut but somewhat susceptible to chinch bug injury.

Feteritas mature early and are better able to produce a crop in seasons of limited moisture than the later-maturing kafirs and milos. Because of their early maturity, they are well adapted to planting as a catch crop in midsummer. They also are very susceptible to seed rots, especially when planted early and without seed treatment. As a result much of the feterita crop is grown from late planting.

There are three recognized varieties of feterita: Standard, Spur, and Dwarf. Of these, Standard feterita is the most frequently grown. It was introduced from the upper Nile region in 1909 by the United States Department of Agriculture and was later distributed in this country. It is most generally grown in Kansas and usually out-yields other varieties of feterita.

The Spur variety was selected from a mixed lot of Standard feterita at the Spur Substation No. 7, Spur, Tex. It is now grown rather extensively in Texas and appears to be more productive than the ordinary Standard feterita in the southern half of the sorghum belt. It matures later, has more leaves, and a less tapering head than the Standard variety.

Dwarf feterita is similar to Spur except that it is shorter in stature. It greatly resembles Spur in maturity, leafiness, and head shape. It appears to have no advantage in yield over Spur and is much less extensively grown at the present time.

DURRA

Durra is characterized by dry stalks, compact, goosenecked, bearded heads, and extremely flattened kernels. It matures early and is fairly well suited to conditions of limited moisture. The plants sucker rather freely. The stalks, being sparsely leaved and dry, are of little value for forage. The chief objections to durra are the frequent shattering of the grain from the heads and the excessive number of hairs on the chaff, which makes threshing disagreeable.

The durras were introduced into the United States and first grown in California in 1874. During the nineties they were grown rather extensively in Kansas under the names of "Jerusalem corn" and "rice corn" but have now largely disappeared from cultivation there. Practically all the durra now being grown in the United States is found in California. The durras are now leading types of grain sorghum in north Africa, Palestine, Arabia, Turkistan, Iran (Persia), and parts of India.

Three varieties of durra are grown in this country. The most popular variety until recently has been the standard White durra (White Egyptian corn or White "Gyp"), which is one of the varieties originally introduced. Its grain has long been used for poultry feed in certain sections of California. The poultrymen pay a premium over other grain sorghums for White durra.

In recent years the Dwarf White durra has been extensively grown in California and is now rapidly replacing the standard White durra. This variety is similar to the standard White durra except that it is much shorter and consequently more easily harvested. The seeds are very similar to those of the standard variety except that they are slightly less flattened. It was originated as a selection from standard White durra by Hoefting Bros., of Chico, Calif.

Brown durra (Brown "Gyp") is nearly identical with the standard White durra except that it has brown rather than white seeds. This variety was introduced with White durra in 1874 and is still being grown to some extent in California, although somewhat sparingly at present. It has no advantage over the standard White durra, and the grain is less palatable.

HEGARI

Hegari (fig. 2) is somewhat intermediate between kafir and feterita in general appearance and characteristics. It has juicy and rather leafy stalks. The heads are erect and resemble those of kafir and feterita. The seeds resemble those of kafir but have a more chalky appearance and a purplish-brown inner seed coat. The plants of hegari usually sucker very freely. Hegari has a wide range with respect to maturity, being relatively early under some conditions and later than any of the kafirs under others. It is also extremely variable with respect to yield, producing very high yields under favorable conditions and very low yields in other cases. It often fails to produce grain in dry seasons. It is sometimes preferred to milo because of its erect heads and leafy, juicy stalks. It is now grown rather extensively in the western and southern portions of Texas, in eastern New Mexico, and under irrigation in the Salt River Valley of Arizona. The best results usually are obtained from rather late planting, ordinarily in June. Hegari is regarded highly as a bundle feed because of its leafy, palatable stalks.

The variety of hegari in this country was named Dwarf hegari. It was selected from a mixed lot of hegari seed introduced from the upper Nile region in 1908 by the United States Department of Agriculture. On the farms, hegari is frequently known as "high gear" or "higeary."

SHALLU

Shallu has tall, slender stalks; long, open, leaning heads; and small, white kernels. The stalks are dry, lacking in leafiness, and of little value for forage. The crop is susceptible to smut, shatters and lodges easily, and matures late. It is seldom grown except in the Gulf region of Texas and Louisiana and there only on a small scale. Shallu was introduced into this country about 1890. At various times it has been exploited under such names as "Egyptian wheat" and "Jerusalem rice corn."

KAOLIANG

The kaoliangs have dry, slender, sparsely leaved stalks; erect, loose, or particularly compact heads; and small brown or white kernels. Many varieties have been introduced into this country from China and Manchuria in the present century. It is believed, however, that only the Manchu Brown variety was distributed to any extent. All varieties mature early and can be grown farther north in this country than any of the other grain sorghums. They cannot successfully compete with corn in the Northern States, however, and are unlikely to reach maturity in a cool season. The crop is of little value for forage because the plants have few leaves and the stalks are too dry and woody for good feed. Manchu Brown kaoliang, which has a semicompact head and small brown seeds, has been distributed from

time to time to farmers in various States from South Dakota southward. It is not known to be grown commercially at present, although small quantities may still be in the hands of a few farmers. Cargoes of kaoliang from Asia occasionally reach the Pacific coast of the United States. These shipments are made either when there is a shortage of grain sorghums for marketing in this country or when a cargo is needed for ballast.

AJAX

Ajax is a medium-late grain sorghum that produces large heads and chalky-white seeds. The stalks are thick, leafy, and rather short. It was developed at Substation No. 12, Chillicothe, Tex., by crossing feterita with a kafir-feterita hybrid. It was distributed about 1930. Ajax is a productive variety in the black lands of Texas and in other sections of Texas and Oklahoma when ample soil moisture is available.

DARSO

Darso (fig. 2) is represented by a single variety having juicy stalks, erect, loose, open heads, and reddish-brown seeds. The plants usually are slightly shorter than those of most kafir varieties but mature about the same time as the early kafirs. The variety tillers somewhat more than most kafirs. Darso is susceptible to smut but appears to have considerable resistance to injury from chinch bugs. It is susceptible to the root and stalk rot that attacks milo. Darso originated on a farm in Oklahoma and apparently is the result of a natural hybrid between two unknown varieties. It was distributed by the Oklahoma Agricultural Experiment Station about 1914 and is now grown to a considerable extent in central Oklahoma. There milo cannot be grown safely, owing to chinch bug injury. Because of its bitter seeds, the crop is seldom injured by birds. This bitter taste of the seeds is disadvantageous, however, in that the grain is rather unpalatable to livestock and poultry.

Darso appears to be rather productive under average or subnormal conditions in the section where it is now grown. Under favorable conditions, and especially in the absence of chinch bugs, darso is likely to be less productive than good varieties of kafir and milo.

SCHROCK

Schrock (fig. 2) is somewhat similar to kafir except that it has shorter and less compact heads and dark-brown kernels with a bitter taste. It is less productive than kafir in most of the grain sorghum region and also is less palatable to livestock. This variety is susceptible to smut but is not injured by chinch bugs any more than are kafir and most sorgos. It originated from a plant found growing in a field near Enid, Okla., in 1911 by Roy Schrock, a rural mail carrier. The crop from this plant was increased and distributed soon thereafter. In the Mississippi Delta area in recent years a strain of Schrock, known as Sagrain, is rather promising for grain production.

FREED

Freed sorghum has slender, sparsely leaved, sweet, juicy stalks; erect, loose, bearded heads; and small white kernels. It tillers rather freely and matures earlier than any of the sorghums so far discussed.

It was selected about 1908 by J. K. Freed, of Scott City, Kans., from a mixed lot of sorgo. It is adapted to conditions of extreme drought and short seasons which prevail in western Kansas and eastern Colorado. Ordinarily, it yields less than kafir and milo where they mature safely.

A selection from Freed sorghum known as Dwarf Freed was made at the Fort Hays Branch Station, Hays, Kans., and distributed about 1926. It is now grown to some extent in western Kansas. The Dwarf Freed variety is considerably shorter than the older standard Freed but appears to have no particular advantage except that it lodges less and is more easily harvested.

A variety called Cheyenne Sweet-Stalked kafir, developed by Albert Weaver, of Bird City, Kans., apparently from a natural hybrid with Freed sorghum, is now grown widely in northwestern Kansas and the adjacent sections of Nebraska and Colorado. It has heavier, more compact heads than Freed and produces more grain.

CHILTEX

Chiltex is a grain sorghum of medium height, maturing in mid-season. It is somewhat intermediate between kafir and feterita. The heads are erect, similar in shape to those of kafir, and they have small, white seeds. The stalks are dry, like those of feterita. Chiltex was originated as a selection from a hybrid between kafir and feterita made at Substation No. 12, Chillicothe, Tex. It was distributed about 1925 and is now grown to some extent in northern Texas and southern Oklahoma, where it usually is more productive than kafir under the limited moisture conditions prevailing in that section.

PREMO

Premo is similar to Chiltex except that it is later maturing and has thicker and more compact heads. Because of its later maturity, it is adapted only to conditions in the southern half of the grain sorghum region. It was originated from the same cross and distributed at the same time as Chiltex.

GROHOMA

Grohoma is medium late in maturity and has rather large, loose, beardless heads and brown kernels. The stalks are rather dry, like those of feterita, but the juice in them is slightly sweet. Grohoma was originated and distributed by Fred Groff, of Britton, Okla., and was offered to farmers in 1929. Its characteristics indicate that it probably originated as a hybrid between feterita and some sorgo. The fantastic stories regarding its origin and value are not substantiated by experimental results nor by its characteristics. The variety is fairly productive under favorable conditions, but it is less productive than kafir and milo under conditions of severe drought.

SEED SELECTION

Grain sorghum seed should be selected and handled with care in order to insure a crop uniform in stand, height, and maturity. Uniformity of the crop is very essential to easy harvesting but is possible only when pure seed is planted. Grain sorghum varieties hybridize

readily when grown near others, including varieties of sorgo, broom-corn, and Sudan grass, that bloom at the same time. Sorghums also occasionally become crossed with Johnson grass. Nearly all grain sorghum fields contain some hybrids. Unless they are removed before the heads appear the hybrids themselves will cross with varieties in the field and thus further contaminate the seed supply. The hybrids can usually be distinguished from the pure variety by the fact that they are taller, grow more vigorously, and mature later, or by their general offtype appearance. Reasonably pure seed can be obtained by selecting heads in the field. The important point is to select only those heads that are typical of the variety with regard to height and maturity and the color and shape of heads and grain. Little or nothing is gained by selecting heads from plants without suckers, as all varieties will sucker more or less when conditions are suitable. Neither is there any advantage in selecting heads only from the main stalks or in selecting for size or type of head in a uniform variety except insofar as purity of the seed may be judged by these characters.

Some hybrid or offtype plants may be produced even from selected seed heads because of natural crossing which occurred while the heads were in bloom. If the crop from the selected heads is to be used for seed, all offtype plants should be pulled or rogued out as soon as they can be distinguished. If a field is nearly pure and is not adjacent to other varieties, good seed can be obtained merely by taking out the rogues before they blossom. The sorghum heads must be covered with paper bags at flowering time to prevent all crossing. This is sometimes done by producers of certified sorghum seed.

The seed heads selected should be free from smut or mold. The latter may destroy germination. The heads should be selected before frost and dried before heavy freezing occurs. If the seeds are frozen while wet or immature they often germinate poorly. The selected heads should be hung up to dry where they will not be injured by storms, insects, or animals.

SEED TREATMENT

All grain sorghum seed should be treated before planting to prevent losses from smut and seed rots. The cost of treating will not exceed a few cents an acre. Dust treatments have proved to be easily applied and are most satisfactory. Copper carbonate, Ceresan (an organic mercury compound), and sulphur dust applied at a rate of 2 to 3 ounces per bushel will largely prevent kernel smut, and the two first mentioned will check seed rots and thereby aid in obtaining stands. Sorghum seed is treated in the same manner as is wheat or cottonseed by the use of a treating machine or barrel churn or by shaking the seed and dust together in a closed can. Sorghum kernel smut also can be controlled by dipping the seed in a solution of formaldehyde or bluestone (copper sulphate), but these liquid treatments are more laborious than dust treatments and more likely to injure the seed. The copper carbonate treatment is preferable to all others.

ROTATIONS

Crop rotation in general is a good method of maintaining crop yields and controlling weeds, insects, and plant diseases. Grain sorghums do not fit well in rotations, however, and the usual benefits

of the rotation may not apply particularly to sorghums. Sorghum plants continue growth until frost, or until the soil-moisture supply is exhausted. This leaves the soil rather depleted of both moisture and fertility. Usually after a sorghum crop, the soil is also in poor physical condition and when plowed is likely to be in large lumps adhering to the numerous fibrous roots of the sorghum stubble. In addition to these lumps, there is apparently some other soil condition or conditions which check the growth of crops immediately following. This deleterious effect is especially pronounced in winter wheat sown immediately after the sorghums are harvested and less pronounced in crops planted the spring following the removal of the sorghums. At present the cause of this deleterious effect is not known. It is supposed by some investigators to be due to a deficiency in the soil of available nitrates following a sorghum crop. Micro-organisms are stimulated by the carbohydrate residues from the sorghum roots and



FIGURE 6.—Plowing sorghum stubble for sorghums.

stubble and are believed to absorb the available nitrates. Under irrigated conditions the deleterious effect can be largely overcome by applications of nitrogenous fertilizers, particularly barnyard manure, and in semiarid sections by fallowing the land for a season before planting other crops.

Likewise, in those portions of the grain sorghum area of the Great Plains where wheat is an important crop, the sorghum crop is usually harvested too late in the season to permit the satisfactory preparation of the land for the sowing of winter wheat. Since most of the difficulties in growing sorghum in rotations are avoided by growing it on the same land, this practice is the usual one where wheat and grain sorghums are the leading crops (fig. 6). The wheat yields from continuous cropping are better than would be obtained following sorghums, and the grain sorghum yields are nearly as good as if they followed wheat.

Where fallow is a desirable preparation for winter wheat it can be introduced following the sorghum in a 3-year rotation of sorghum,

fallow, and wheat. Grain sorghums often are alternated with sorgos, Sudan grass, broomcorn, or corn.

In those sections where cotton is an important crop, the growing of grain sorghum and cotton in rotation is not considered a desirable practice. Grain sorghums following cotton will yield as well as, or even better than, grain sorghums following a grain sorghum crop, but the cash crop, cotton, is more productive when grown continuously than when grown in rotation with grain sorghums.

Growing spring barley on sorghum land is a frequent practice in northwestern Kansas in changing a field from grain sorghums to wheat. The yields of spring barley following grain sorghums apparently are as good as those following corn or other cereals, and as wheat can be grown satisfactorily following the barley little loss is incurred in making the change. Where corn is grown it can be used as a crop to fill in between grain sorghums and wheat, and this

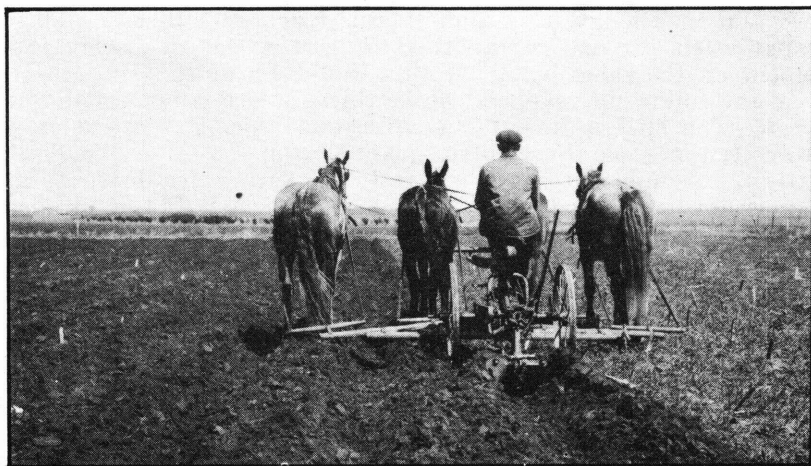


FIGURE 7.—Listing up a poor stand of wheat to plant kafir.

is frequently done where it is desired to shift from sorghums to winter wheat.

Grain sorghums frequently are planted on land where winter wheat has failed owing to drought, soil-blowing, or winter-killing. The wheatfield then is disked or listed (fig. 7), and the sorghums are listed in soon thereafter. This changes the usual continuous cropping and necessitates the growing of some wheat on sorghum land in the year or years following, when the wheat acreage is again increased.

In the southern Great Plains, experiments show that grain sorghums usually produce more following fallow, winter grain, cowpeas, or cotton than in continuous culture. Milo, especially, responds well to the additional moisture conserved by fallowing, the yields in western Kansas being approximately double those from land continuously in sorghums. Fallowing has not been so successful a practice for grain sorghum growing in experiments in Oklahoma, Texas, and New Mexico as in Kansas. Rotations recom-

mended for western Kansas are (1) fallow, winter wheat, grain sorghum and (2) fallow, grain sorghum; and in northwestern Kansas, grain sorghum, spring barley, winter wheat. If preferred, either grain sorghum or wheat may be grown for 2 consecutive years, making the rotations described 1 or 2 years longer.

In northwestern Oklahoma, northwestern Texas, and eastern New Mexico, experiments show that grain sorghums yield more after cowpeas or small grain than after sorghums. Farther south in Oklahoma and Texas, experiments show grain sorghums to yield well after cotton, the leading crop.

In the irrigated sections of southern California and Arizona, the grain sorghum crop usually follows small grain, either wheat or barley, in the same season. The wheat or barley is sown during the late fall or early winter and is harvested in late May or early June. After harvest, the land is plowed, irrigated, and planted to grain sorghums, usually milo or hegari, during the latter half of June or early July. The grain sorghum crop reaches maturity, and can be harvested in time for another crop of wheat or barley to be planted on the same land, but this would result in low yields of grain the following year, and hence this practice is not usually followed. The land ordinarily lies over until spring, when it is put into cotton or some other spring-planted crop.

Grain sorghums are grown mostly on rather fertile soils, and commercial fertilizers are rarely used on the crop. If the soil seems to require fertilization the material and quantities necessary should be about the same as for corn in the same locality.

SEEDBED PREPARATION

Good seedbed preparation is important for grain sorghums, particularly in securing stands, controlling weeds, and conserving moisture. Working the ground mellows and warms the soil, which aids in securing better stands. Ample tillage prior to planting usually will well repay the labor involved. Fewer cultivations after planting are necessary if the weeds are kept well under control during the spring prior to planting.

Land for sorghum usually is worked in early spring, although late fall or winter listing or plowing sometimes is practiced. Experiments in general favor fall or winter tillage. The spring operations usually begin after weed growth has started. After weed growth is resumed the land may be worked a second time.

The common methods of preparing land for grain sorghums are listing, plowing, disking, and the use of the "one-way." This is a heavy disk implement with large disks arranged to throw all the soil in one direction (fig. 8). The listing method is rapid and is particularly advantageous on soils subject to blowing. The listing is done either with horse-drawn (figs. 7 and 9) or tractor-drawn (fig. 10) listers, those drawn by horses being either one-row or two-row implements. The one-row listers are drawn with three or four horses or mules (fig. 7) and the two-row listers with six (fig. 9) or occasionally eight.

One man with a two-row lister can cover about 14 acres a day. Three-row listers require a tractor having about 15-drawbar horsepower for satisfactory operation and will cover about 30 acres a day.

The second operation usually consists of breaking or leveling the ridges (figs. 11 and 12) or in splitting the ridges with the lister. Often the listed land is relisted and planted during the same operation.



FIGURE 8.—A "one-way" disk working wheat-stubble land.



FIGURE 9.—Blank listing land for kafir.

Plowing or "flat breaking" (fig. 6) is a common method of tillage in the eastern portion of the grain sorghum region. This method has proved superior to most listing methods as a preparation for

grain sorghums in experiments in the Great Plains. Plowing, with subsequent tillage, requires considerably more labor, however, than the lister method of preparing ground and for this reason is less popular in the semiarid western Great Plains, where economical production is

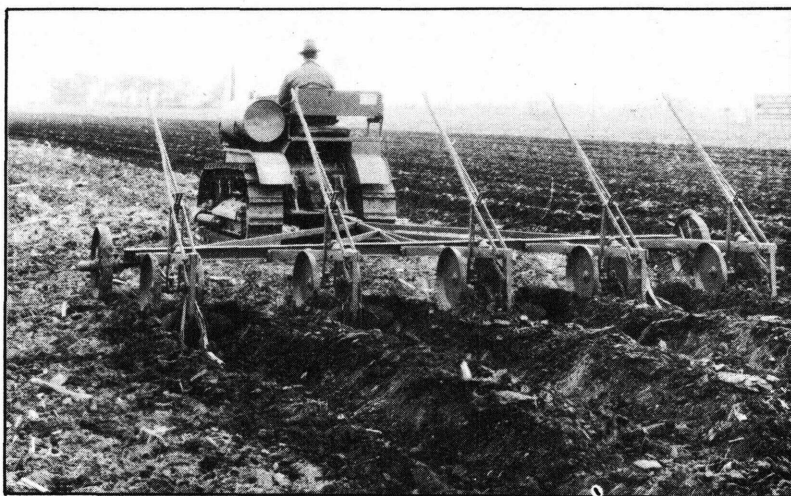


FIGURE 10.—A five-row tractor lister.

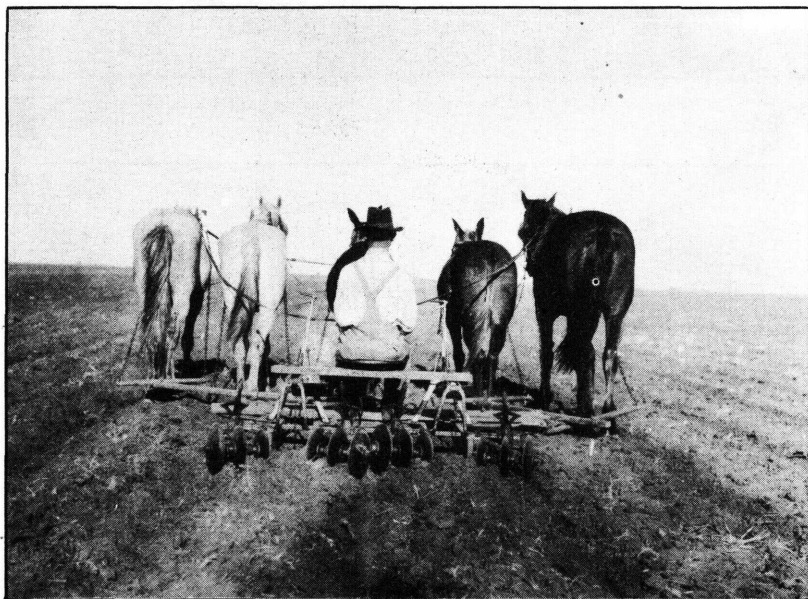


FIGURE 11.—A two-row go-devil being used to level lister ridges.

imperative. Gang plows drawn by five horses are used most generally. Such a plow will cover about 5 acres a day if the soil is not too heavy. After being plowed, the land must be disked or harrowed, or both, before it is planted.

Disking and cultivating with the one-way in preparation for grain sorghums are done chiefly in conjunction with the lister planter. The disk or the one-way destroys weed growth and volunteer grain and helps to prepare a seedbed before the crop is listed in. A satisfactory seedbed for planting with a surface planter usually cannot be obtained by disking alone. Land disked in the spring usually is not worked again until planting time, when the crop is planted with a lister. Occasionally, the land is disked or one-wayed after it has been listed.

PLANTING METHODS

LISTER AND SURFACE PLANTING

Grain sorghums are usually planted either with a lister planter (figs. 13, 14, and 15) or with a corn planter (figs. 16 and 17) equipped with special sorghum dropping plates, which are supplied

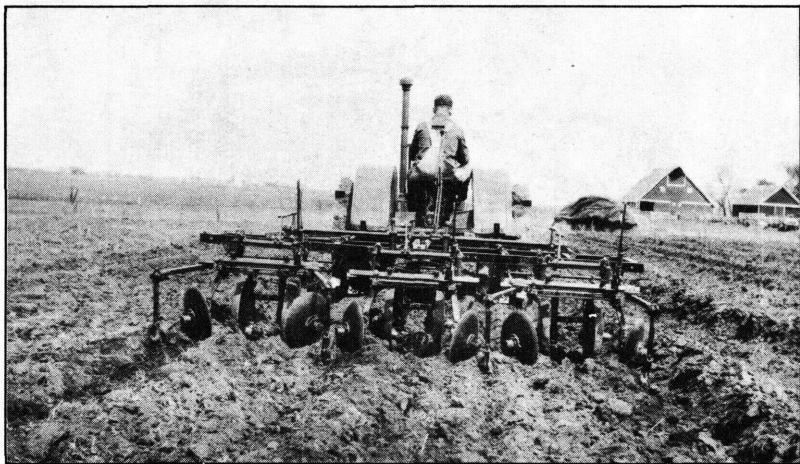


FIGURE 12.—Breaking ridges with a three-row tractor cultivator.

by the implement manufacturers. The sorghum plates have smaller holes than the corn plates, the holes usually being either three-sixteenths or one-fourth of an inch in diameter. The plates with the larger-sized holes are used mostly for planting feterita and milo and those with the smaller size for kafir and other sorghums.

Corn planters are used for planting sorghums either in leveled lister furrows or in fields prepared by plowing. Often the corn planters are equipped with disk furrow openers (fig. 16) in order to place the seed in a furrow where the soil is moist. This method combines the advantages of furrow planting with those of surface preparation.

Lister planting is practiced to some extent in the eastern or sub-humid portion of the grain sorghum region and is the predominating method in the southern Great Plains. Planting in lister furrows usually places the seed in moist soil, insures the formation of crown roots at sufficient depth, and checks soil blowing. On the other hand, this method, as commonly practiced, usually places the seed

in cold soil, which delays and reduces the germination of the seed, retards the growth of the young plants, and delays maturity slightly. Only in case of a summer drought are the reduced stand and delayed growth from lister planting advantageous. Sorghum stands in lister furrows are often destroyed by heavy rains which wash soil into the bottom of the furrows, covering the young plants or seeds too deeply. On rolling lands where the furrows run up and down

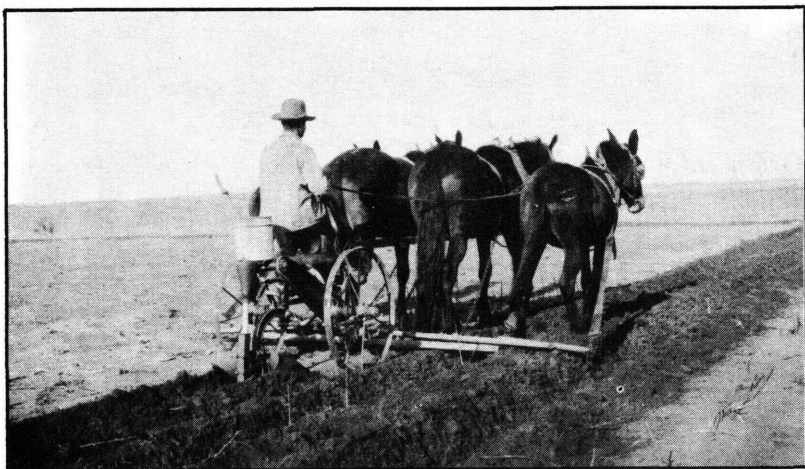


FIGURE 13.—Planting milo with a single-row lister planter.



FIGURE 14.—Planting milo with a two-row lister planter.

the slope the seeds may be washed out of the soil on the steep slopes and buried under several inches of soil at the bottom of the slope.

In lister furrows that have been leveled or filled in and then later partly "nosed out" in planting, or in plowed fields planted in shallow lister furrows, better stands are secured in the warm, mellow soil, and the shallow furrows with wide bottoms and gently sloping sides are less subject to soil washing and the burying of seed.

The method of planting land listed late in the fall or early in the spring has usually produced excellent stands and a good growth at the Fort Hays (Kans.) Branch Station. If additional tillage is necessary between the ridge breaking and planting, the land is worked with a disk or a one-way.

Perhaps the most general planting practice in the grain sorghum region consists of splitting the ridges of blank-listed land and planting with a lister during the same operation. Although economical of labor this method has been found in extensive experiments frequently to result in poor stands and poor yields.

Occasionally, grain sorghums are listed in without any previous preparation. This method also usually produces poor stands and unsatisfactory yields.

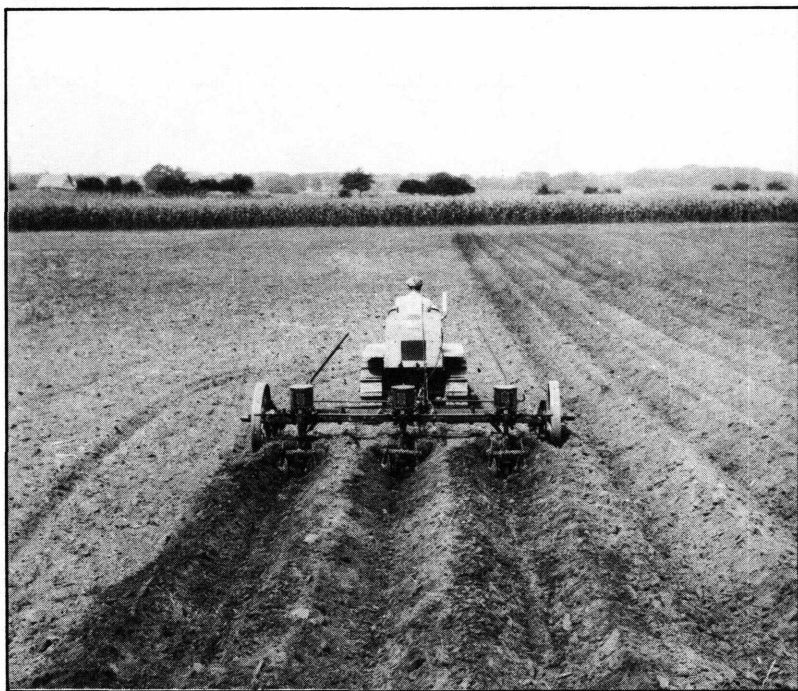


FIGURE 15.—A three-row lister planter drawn by a tractor.

WIDE-ROW PLANTING

In the drier western portions of the sorghum belt, an optional method is to plant in rows twice the usual distance apart. The purpose is to conserve moisture in the early part of the season for use later when the crop is maturing and in greater need of it. Also, the ground is left in better condition for the following crop. The same result is sometimes secured by planting with the usual spacing between rows and later, provided a good stand is obtained, cultivating out every other row. If for any reason the stand is thin the rows are left as they were planted. A variation of the wide-row method consists in growing the crop in alternate wide rows and

ordinarily spaced rows. Thus, pairs of rows spaced the usual distances (36 to 44 inches) are separated from other pairs by twice these distances.

In very dry seasons sorghum in wide-spaced rows will often produce grain when that spaced in the usual way will fail completely. On an average, however, yields of both grain and fodder are less in the wide-spaced rows, the difference in yield of grain being about 5 percent for milo and 10 percent for kafir. The differences in the yield of forage are usually much greater.

DEPTH OF PLANTING

The seeds of grain sorghums should be covered with 1 to 2 inches of soil in planting. Shallower planting may allow the surface soil to dry before the seed is germinated, and deeper planting retards the emergence of the seedlings.

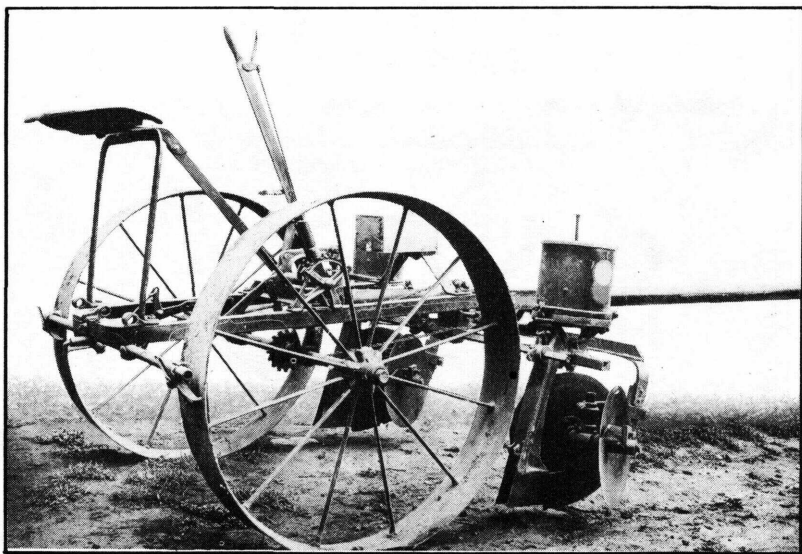


FIGURE 16.—A two-row corn planter with disk attachments.

RATE OF PLANTING

The most satisfactory rate for seeding grain sorghums depends on several factors. Assuming good seed, suitable preparation of the ground, and timely planting, the most important considerations are the variety and the supply of moisture likely to be available. Milo, for example, suckers freely and appears to have a greater ability than other varieties to regulate the number and size of heads according to the space and moisture available. Thinner planting and less seed, therefore, is required than for most other varieties. Thicker planting is usually considered desirable in the eastern part of the sorghum-growing area, where moisture is likely to be plentiful, than in the western portions, where it is likely to be deficient, and the same would be true of bottom land as compared with upland in the same area.

More seed should be used when grain sorghums are planted in lister furrows than when planted in shallow furrows or near the surface, for the reason that conditions for germination and early growth of the plants are less favorable and the stand as a consequence is likely to be thinner. For a similar reason more seed is used if it is planted early, if the ground is poorly prepared, if the seed is low in germination, or if for any reason it is anticipated that germination and emergence are likely to be less than normal.

The field germination and emergence of sorghum seeds are usually considerably less than might be expected on the basis of laboratory tests. Good seed planted in well-prepared ground at a favorable time may produce 60 to 75 percent as many plants as there were seeds planted. Usually, however, not more than 50 percent should be expected, and from two to three times as much seed should be

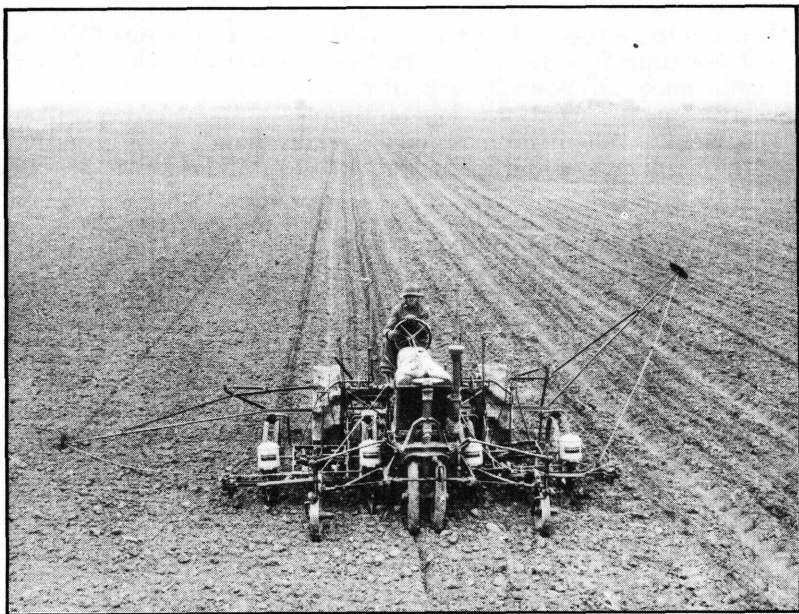


FIGURE 17.—A four-row surface planter mounted on a tractor.

planted as would be necessary to give the desired number of plants per row should all seed germinate. This sometimes will result in a stand that is too thick, but only in dry seasons will the yield be affected materially, and on an average the loss will be less than would otherwise occur because of thin stands.

Kafir usually produces the best yields of grain when the plants are spaced not more than about 6 inches apart in the row. Only in extremely dry seasons are the grain yields likely to be increased by thinner spacing, and even then the distance between plants should not exceed 12 inches. Where moisture is ample, kafir plants may be spaced only 4 inches apart in the row without detriment.

Average good kafir seed will run about 18,000 to 20,000 seeds per pound. On this basis, with ordinary rows spaced 42 inches apart

and spacing the seeds 6 inches apart in the row, there would be required about $1\frac{1}{4}$ pounds of seed per acre. As indicated above, however, it is usually desirable to plant from two to three times this amount to allow for poor germination and loss of plants during early growth. For average conditions about 3 pounds of good seed per acre will be required. If conditions are unfavorable at planting time, the rate of planting may be increased to 4 or 5 pounds of seed per acre. If moisture is likely to be deficient but conditions for germination are satisfactory, not more than 2 pounds of seed per acre should be used. Small-seeded kafirs such as Dawn and Sunrise will not require quite so much seed per acre as the Blackhull and other well-known varieties.

Hegari, darso, and Schrock ordinarily are planted about as thickly as kafir. Darso and Schrock are usually grown east of the Great Plains, where moisture is not so limited. Freed sorghum requires rather thick spacing similar to that of kafir for maximum yields because of the small heads.

Milo produces the best average yields when the plants are spaced 1 to 2 feet apart in the row. However, since milo has a marked ability to make adjustments according to the space available, planting may be considerably thicker or thinner without any great effect on the yield. Where milo is harvested by hand, as is usually the case, the thinner spacing is desirable, because the heads are fewer and larger.

Milo seeds are considerably larger than kafir seeds, the number per pound being usually about 12,000 to 15,000. One pound per acre in ordinary rows would result in one seed every 9 to 14 inches in the row. It is usually considered desirable to plant $1\frac{1}{2}$ to $2\frac{1}{2}$ pounds per acre to allow for poor germination and emergence under field conditions.

The seeds of feterita are larger than those of milo and kafir, and usually they do not germinate so well. In order to obtain stands with plants 6 to 12 inches apart in the row, which is considered desirable, it is usually necessary to plant about 3 to 4 pounds per acre.

Thick planting is desirable for all grain sorghums grown for forage. Fodder yields are usually highest from thick planting, and the stems are finer. Kafir and hegari grown in rows for forage should be planted at a rate of not less than 5 pounds of seed per acre.

DATE OF PLANTING

Sorghums are warm-weather crops. The seeds will not germinate and the plants will not grow satisfactorily if planted too early in the spring. It is therefore advisable to delay planting until the soil is warm. This usually means planting at least a week after normal corn-planting time. If it is necessary to plant while the soil is still cold, the seed should be treated with copper carbonate or some other good dust fungicide. This treatment helps to control the molds which usually are abundant in the soil and which are likely to rot the seeds in cold soil. The soft, starchy seeds of such varieties as the feteritas and Wonder kafir are especially subject to injury from early planting.

Sorghums appear to reach a better final development when permitted to make rapid continuous growth throughout the period from planting to maturity without being checked or delayed by adverse weather. Early planting may cause the crop to come into head during midsummer when the temperatures are likely to be extremely high. Such temperatures, combined with dry weather, frequently check the growth. It has been observed that under most conditions, both in the Great Plains and in the irrigated sections of the Southwest, a better yield is likely to be obtained if the time of planting is such that the plants come into head after the period of midsummer heat rather than during this period.

In the southern parts of the grain sorghum region, where the soil warms up early, the crop can be planted from March until early August, with a good chance of reaching maturity. In the northern portion of the region, however, where the growing season is short and where the soil does not become warm until after May 15, the period during which sorghums can be planted is rather limited. In general, the best time for planting lies between May 15 and July 1. However, because of the danger of early fall frosts it is necessary that the later-maturing varieties, such as Blackhull kafir, be planted as soon as feasible after the ground becomes warm. This will usually be about May 15 or shortly thereafter. The early kafirs and the milos can be planted somewhat later, but June planting usually gives the best results. The feteritas, which grow rapidly and mature rather quickly and which are also especially subject to injury from low temperature during early growth, ordinarily should not be planted until rather late in the season and in most cases not earlier than about June 15. If grain sorghums are to be planted earlier, some variety other than feterita should be grown. Hegari appears to make its best development when planted rather late when the temperatures are high; under such conditions it develops rapidly and continuously from the time of planting until maturity.

In any particular season the date on which the seed producing the highest yield was planted may vary according to the soil-moisture supply and variations in temperature during the season. An untimely rainstorm or drought may preclude satisfactory stands. If moisture is lacking at critical periods in the development of a crop, the yield may be reduced considerably, whereas a crop planted 2 weeks earlier or later may largely escape drought injury at the critical heading period. Numerous experiments have shown that, in general, relatively late planting tends to produce the maximum yields. It is not advisable to delay all planting until the latest optimum date, because the occasional loss of a stand, requiring re-planting, may cause the crop to be too late to mature. It is important that the crop reach full maturity before frost is likely to occur. Sorghums should not be planted too early in deep lister furrows.

These recommendations are valid where serious insect injury to sorghums usually does not occur. Where insects are an important factor, it is often necessary to follow cultural practices that are otherwise not the most favorable for the production of the crop. In eastern Kansas, Oklahoma, and Texas, particularly in those sections where small grains are grown, chinch bugs are often very injurious to grain sorghums. These insects migrate from the grainfields

at harvesttime and attack the sorghum plants when they are rather small. The insects are particularly injurious to milo and practically prohibit the growing of this crop on a commercial scale in the eastern half of Kansas and Oklahoma. Chinch bugs injure the plants by sucking out the juices. The larger the plants the better they are able to survive chinch bug injury. Where chinch bugs are a factor, therefore, it is advisable to plant the sorghums relatively early in order to avoid as much loss from chinch bugs as possible. In southern Oklahoma the grain sorghums should be planted before May 1, if possible. Plantings made after this date are likely to show progressively increasing injury from these insects.

The sorghum midge is very prevalent in the Gulf region and occurs throughout the eastern half of Texas. It is a serious factor in grain-sorghum production anywhere within 300 miles of the Gulf of Mexico in Texas and Louisiana. The midge deposits eggs in the individual sorghum flowers at heading time. The egg hatches, and a small larva develops in the ovary of the flower and prevents the formation of a seed. The midge is present in greatest numbers in midsummer, and sorghums that come into head at this time are likely to produce no grain. The common method, therefore, of reducing losses from sorghum midge is to plant in March in southern Texas, which permits the grain sorghum to come into head during May or early June, before the midge has become very abundant. Later plantings of grain sorghums doubtless would be more productive were it not for the midge, but planting in March or even in February is the most effective method known for reducing losses from this insect.

CULTIVATION

The primary object of cultivation is to control weeds. Weeds injure the crop chiefly by using up moisture and soil fertility that the crop needs; large weeds also may shade the crop too much and occasionally interfere with harvesting. The time and frequency of the cultivation given consequently depend largely upon the weeds.

The methods of cultivating grain sorghums depend to some extent upon whether the crop is planted with a surface planter or with a lister, but they usually are the same as for corn in any particular locality. Surface-planted fields often are harrowed lightly with a spike-tooth harrow when the plants are coming up or soon thereafter. The harrowing destroys many small weeds and breaks light crusts which may retard the coming up of the young plants. After the harrowing, the crop is usually cultivated two to five times with an ordinary corn cultivator, the number of cultivations depending on the weediness of the fields. Some growers omit the harrowing and use only the cultivator.

Lister-planted grain sorghums require special lister cultivators for part of the operations. The first cultivation is usually given with a "curler", go-devil, or knife sled. The disks on the "curler" (fig. 18) are set to throw the dirt out of the furrow in the first cultivation. Weeds in the furrow are cut off, and those on the ridges are buried by the dirt that is thrown up. Small shovels behind the disks destroy the weeds near the row. Tractor lister cultivators covering three or six rows are now being used (fig. 19). The go-devil (fig. 11) is a sled cultivator having a gang of disks and a blade on each side to

destroy weeds. The disks can be set to throw the dirt in or out of the furrow. The knife blades cut off the weeds growing on the ridge. Two-row go-devils sometimes are used, but the one-row machines are more common. Knife sleds are mostly two-row, home-made cultivators, consisting of a pair of runners which straddle the rows of plants but run inside the furrow between the two ridges (fig. 20). Knife blades, extending diagonally out and back from the runners and running beneath the soil surface, cut off the weeds on the ridges.

After the first cultivation the listed crop sometimes is harrowed. The harrowing levels off the tops of the ridges and moves some soil into the furrows, thus uprooting or burying the weeds. The leveled



FIGURE 18.—A two-row lister cultivator or "curler."

ridges make walking easier for the horses in the third cultivation. In the final cultivation, with lister cultivators, the disks are set to throw the dirt into the furrow to bury the weeds in the furrow, cut off the weeds growing on the ridges, and level the field to make harvesting easier. In most of the semiarid grain-sorghum districts two cultivations are given the listed crop, a "throwing-out" and a "throwing-in", often with an intermediate harrowing. Failure to complete the final cultivation of throwing-in, as occasionally happens because of rush of work, leaves the field very rough at harvest-time. If an additional cultivation following the throwing-in is deemed necessary or desirable, this usually is done with an ordinary surface cultivator.

IRRIGATION

Nearly the entire grain sorghum crop of Arizona, most of that in California, and some of that in Colorado, New Mexico, Kansas, and Texas are grown under irrigation. The chief sections where grain

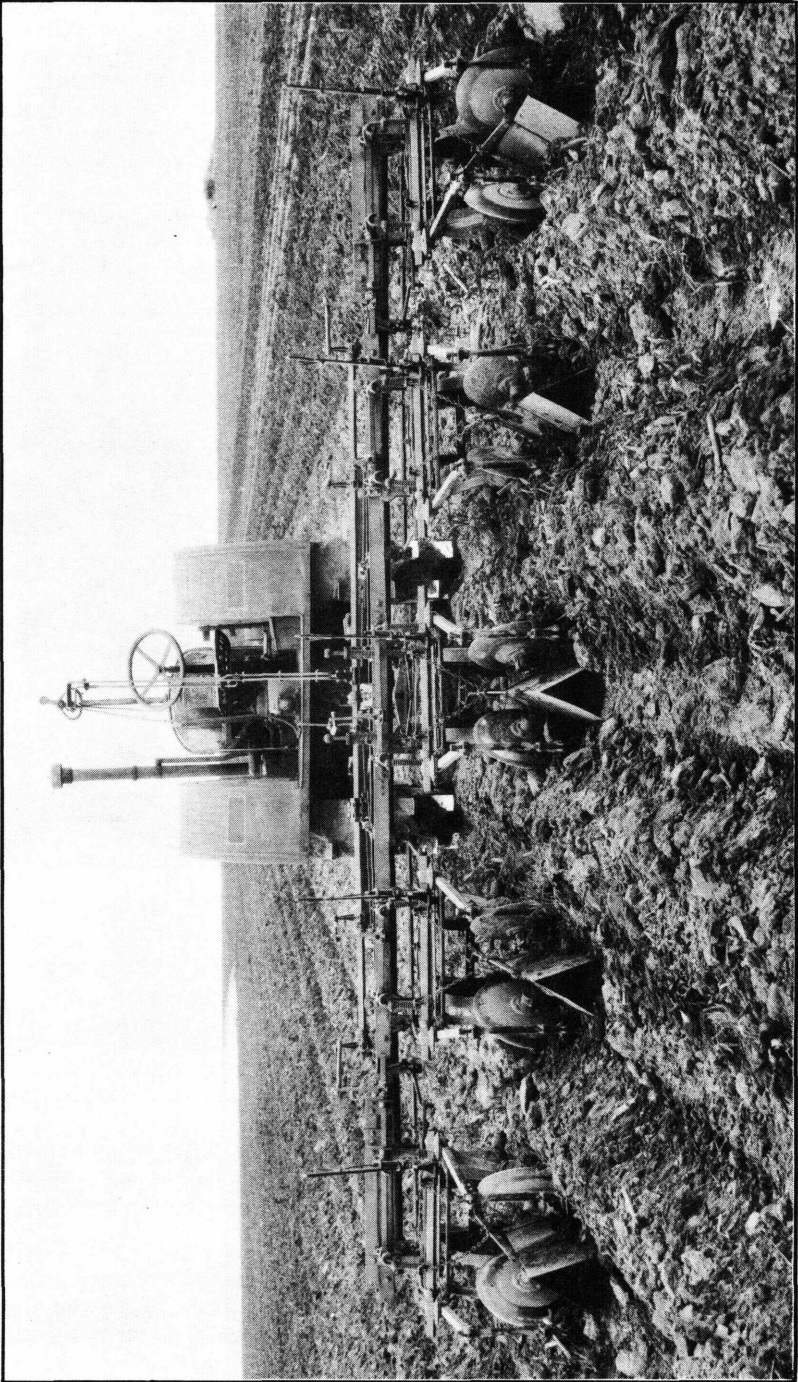


FIGURE 19.—A five-row lister cultivator.

sorghums are grown under irrigation are the San Joaquin, Sacramento, and Imperial Valleys of California; the Salt River, Gila, and Yuma Valleys of Arizona; and the Arkansas Valley of Colorado and Kansas. Most of these irrigated lands are devoted to the production of high-priced cash crops such as cotton, sugar beets, truck crops, and fruits. Consequently, the grain sorghums usually are grown in small fields, largely for the production of feed for use on the farm. In the San Joaquin Valley, however, grain sorghums often are grown on a large scale for market.

When soil and seasonal conditions are satisfactory, high yields of grain sorghums can be produced on irrigated land. Yields of 75 bushels or more per acre are not unusual on good irrigated lands.

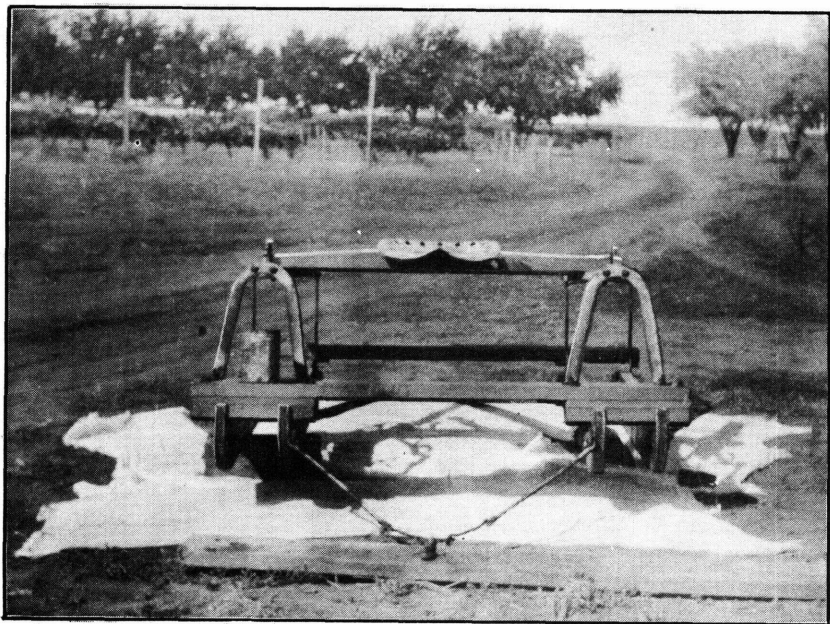


FIGURE 20.—A two-row knife-sled cultivator.

Double Dwarf milo and Dwarf hegari are the most popular grain sorghums for irrigated farms, although other varieties such as Dwarf Yellow milo and Dwarf White durra also are grown to a considerable extent. Hegari is preferred to milo when silage or bundle feed is desired.

Because of the ability of milo to produce high yields when conditions are favorable, this crop has proved to be especially valuable for irrigated lands. It is also able to adjust itself to a deficient water supply.

When growing grain sorghums under irrigation, the land is usually irrigated before being prepared or after plowing. As soon as the soil is dry enough it is plowed and harrowed or simply harrowed, and the crop is planted immediately. In some cases the harrowing and planting are done in a single operation by the use of large tractors and large planting units (fig. 21). After the crop is up, the land is

irrigated often enough to maintain a supply of soil moisture, provided water is available at not too great an expense. The number of irrigations after the crop comes up varies from none to six, but usually from one to three, depending on climatic conditions, supply of water, and texture of the soil.

Grain sorghums under irrigation are usually planted rather thick in order to insure a good stand. Where moisture supply is not a limiting factor there will be little reduction in yield from thick stands, and obtaining a full stand is essential for a maximum yield. From $2\frac{1}{2}$ to 5 pounds of seed per acre are usually planted, $2\frac{1}{2}$ pounds being ample for rows spaced 3 to 4 feet apart in a good seedbed. Under some conditions milo is planted in rows 24 to 32 inches apart, proportionately more seed being used. Often the narrow rows are not cultivated after the crop comes up, except possibly for a harrowing just when the plants are emerging. Sorghums on irrigated lands

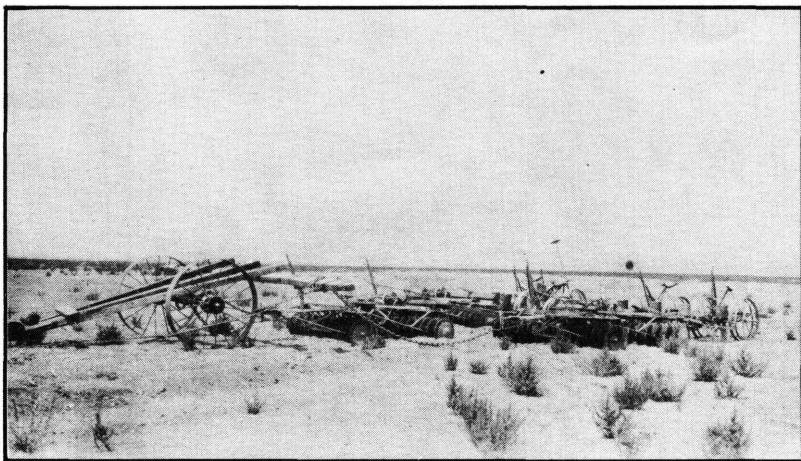


FIGURE 21.—Tractor hitch, tandem disks, and planters used in preparing irrigated land and planting 10 rows of milo in one operation.

are usually cultivated with the ordinary surface cultivating machinery such as is used with corn. Cultivation between irrigations leaves small furrows between the rows in which the irrigation water can flow.

In irrigated sections where frost seldom occurs grain sorghums often volunteer by reseeding and by sending up suckers after the crop is cut. Eradicating them from the fields may be rather difficult.

HARVESTING AND THRESHING²

Grain sorghums are ready for harvest when the seeds are fully colored and have begun to harden. For harvesting with a combine the seeds should be well dried, as the grain will not be likely to keep in storage if it contains more than about 14 percent of moisture.

Grain sorghums are harvested by four general methods: (1) Heading by hand, (2) heading by machinery, (3) cutting with a row

² For a more complete discussion of harvesting and threshing grain sorghums see Farmers' Bulletin No. 1577, Harvesting Grain Sorghums. Out of print, but may be consulted in libraries.

(corn) binder, and (4) harvesting with a combine. Hand heading is the usual method of harvesting milo and consists of cutting off the heads with a knife (fig. 22) and throwing them into a wagon which is driven along the row. A man with a team and wagon can

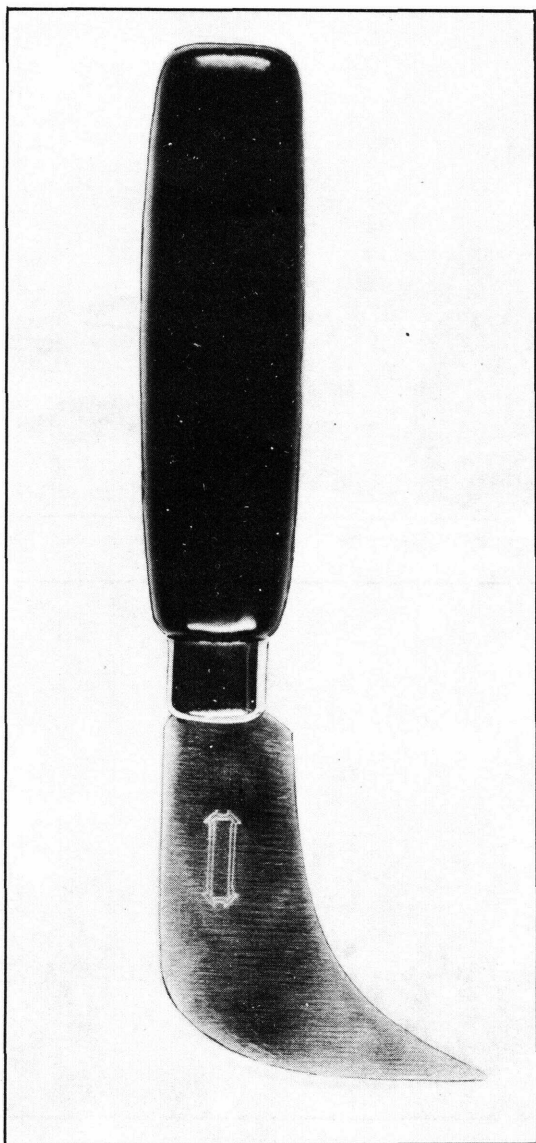


FIGURE 22.—Knife used for heading grain sorghums by hand.

head by hand $1\frac{1}{2}$ to 2 acres a day. Machine heading is done usually with a grain header, which frequently cuts 10 to 20 acres a day, with certain adjustments and changes to facilitate the operation (fig. 23). Special one-row wagon-box headers (fig. 24) cutting 3

to 5 acres a day are also used for harvesting erect-headed varieties. Much of the kafir and hegari grown for grain only is cut with a header. The heads are piled in ricks to dry before threshing. The row binder (fig. 25) is used for cutting grain sorghums, particularly

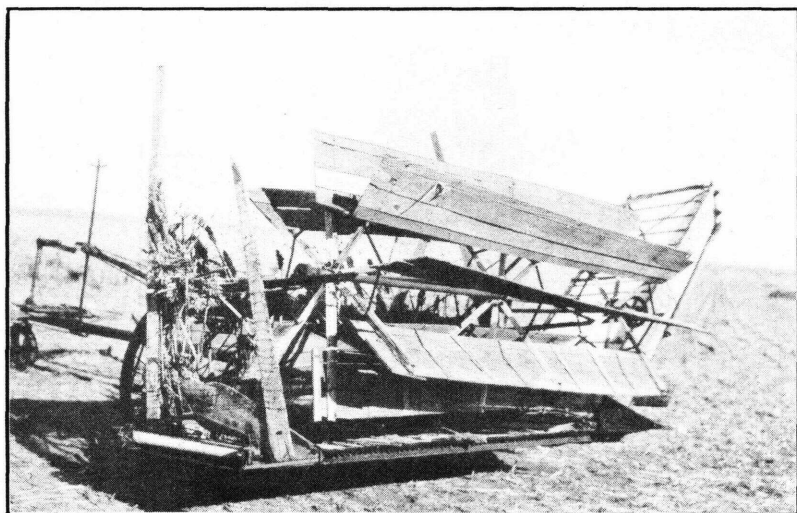


FIGURE 23.—Extra reel slats and wire screen on a grain header used for harvesting kafir.

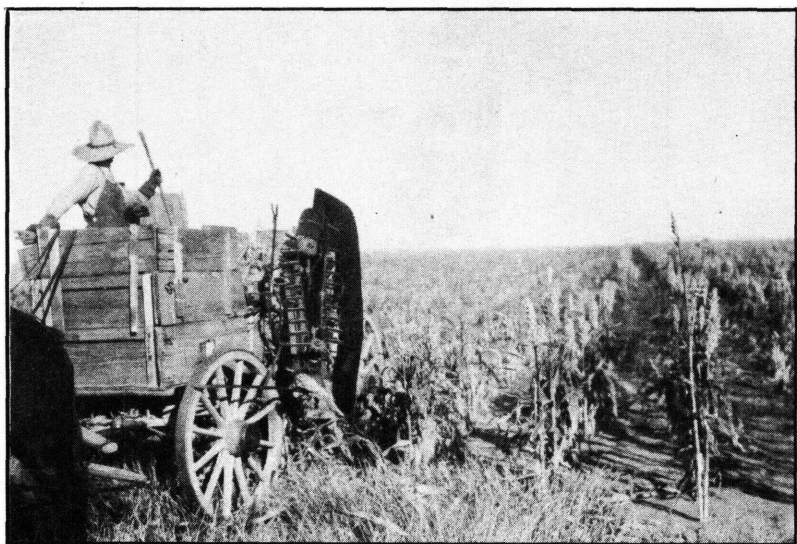


FIGURE 24.—A one-row kafir header attached to a wagon box.

kafir, where the stover is desired for feed. The bundles are shocked for curing before being fed or threshed. Binding is the usual method in the central and eastern parts of Kansas and Oklahoma. Harvesting with a combine (fig. 26) is satisfactory for well-matured, dwarf,

erect grain sorghums. The combine saves considerable labor but may entail greater harvesting losses and increases the difficulties of storing the grain.

Grain sorghums do not ripen uniformly. The seeds at the tip of the heads ripen first, and the ripening proceeds downward on the heads.



FIGURE 25.—Harvesting kafir with a row binder.



FIGURE 26.—Harvesting and threshing milo with a combine.

The heads on the main stalks usually ripen before those on the sucker stalks. Green heads on late tillers and stalk branches usually are present in a field until frost occurs or the soil-moisture supply is exhausted. The small branch heads which appear along the stalks

seldom are large enough to be worth harvesting and merely interfere with the uniform maturing of a field. Harvesting with a combine is feasible only when the grain is fully ripe and dry or when grain-drying equipment is available.

Threshing is done either with a grain separator or a combine. The machine is pulled up to a rick of heads, and the heads are pitched into it. Grain-sorghum bundles usually are topped with a special large knife, the severed heads only being put into the thresher. The so-called "cheese knife" usually is attached to a wagon, and the bundles are topped in the field before the heads are hauled in (fig. 27).

Threshing machines have to be adjusted to reduce the cracking of the sorghum grain. Cracked grains are much more likely to go out of condition than whole grains, and if a bin contains a considerable percentage of cracked grain, heating is likely to occur.

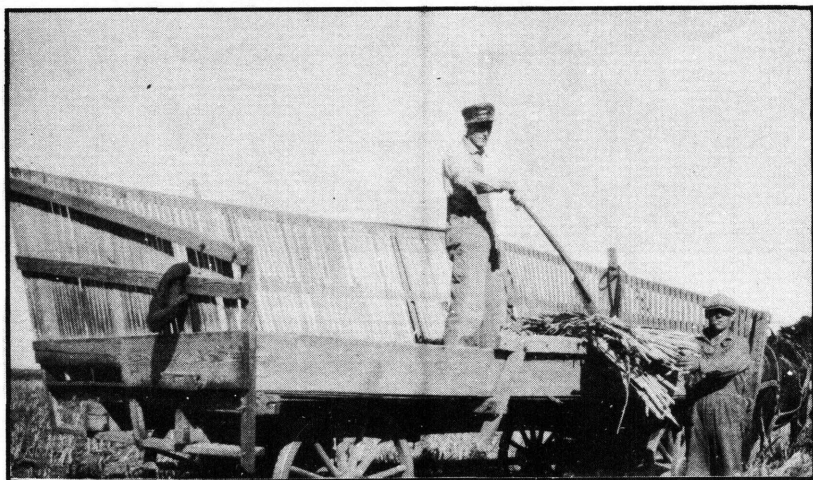


FIGURE 27.—Heading bundles of kafir with a "cheese knife."

DISEASES

The principal diseases attacking grain sorghum in this country are covered kernel smut, loose kernel smut, head smut, rust, seed rots, and blight.

Sorghum smut is not poisonous to livestock. Large quantities of smut have been fed without any harmful effects. Most sorghum kernel smut spores are killed by passing through the digestive tracts of farm animals, so there is little danger of spreading the smut through the medium of barnyard manure.

Covered kernel smut (*Sphacelotheca sorghi* (Link) Clinton) (fig. 28) includes several different physiologic forms each of which may attack different varieties. The best-known form may attack all grain sorghums with the exception of feterita, milo, and hegari, as well as all sorgo and broomcorn varieties. Another form attacks milo and hegari and all other cultivated varieties of grain sorghum in this country except feterita. Forms of smut that can attack feterita readily appear to be of unusual occurrence.

Covered kernel smut is carried on the seed and can be controlled by the use of a formaldehyde solution or with dust treatments such as copper carbonate, sulphur, and Ceresan.

Loose kernel smut (*Sphacelotheca cruenta* (Kühn) Potter) is similar to covered kernel smut except that the galls in the infected heads are longer and more frequently broken. Loose kernel smut attacks most of the grain sorghums readily but attacks feterita and milo only rarely. This disease is controlled by the same methods as is covered kernel smut.

Head smut (*Sorosporium reilianum* (Kühn) McAlpine) attacks the heads, usually destroying them entirely and leaving a black mass of spores. This disease is carried over in the soil, where it infects the



FIGURE 28.—Smutted and sound (center) heads of kafir.

young sorghum plants, but it is seldom abundant. Seed treatment is of no benefit. The only method of control seems to be the destruction of diseased heads as soon as they appear.

Sorghum rust (*Puccinia purpurea* Cke.) sometimes attacks the leaves of grain sorghums. This disease can be identified by the pustules of brown spores found on the surface of the leaves, usually late in the season. It is not known how seriously the grain sorghums are injured by rust, but usually the damage is slight because the infection develops mostly after the heads are practically mature; heavy infections rarely occur. No remedy is known, but there is considerable difference in the resistance of varieties. Milo usually shows little rust injury.

Sorghums are attacked by at least three types of leaf blight or spotting diseases (*Bacterium andropogoni* E. F. Smith, *B. holci* Kendrick, and *B. holcicola* Elliott), which are caused by the entrance

of certain bacteria into the leaf tissues. These diseases cause red or reddish-brown spots or stripes on the leaves, sometimes being severe enough to cause the entire leaf to die and dry up. Like rust, these diseases usually occur after the growth of the plant is advanced and consequently may not cause serious injury. All of the grain sorghums except shallu appear to be rather susceptible to at least some of these leaf blight diseases.

Frequently grain sorghums planted in cold soil do not germinate well. An examination of the seeds that fail to produce plants shows that, as a rule, the seeds have rotted instead of germinated, or have decayed shortly after germination, before the plants came up. When the soil is warm very little of this rotting occurs. This decay is caused by organisms in the soil, which develop under temperatures lower than those best suited for the germination of the seed. At high temperatures the seeds germinate rapidly, and the soil organisms make less growth. The rotting of sorghum seed can be prevented to a large extent by waiting until the soil is warm to plant them, and by treating the seed, before it is planted, with ordinary seed-treating chemicals such as copper carbonate.

Seedling blight and wilt diseases caused by various soil-borne organisms, some of which also produce seed rots, may reduce the stands of sorghum after the plants have come up. These diseases are controlled to some extent by the seed treatments already mentioned.

A root and stalk rot caused by *Pythium arrhenomanes* Drechs. attacks milo and darso but does not injure other grain sorghums appreciably. Usually it prevents the affected plants from heading. The disease appears to be most serious where milo is grown continuously or in short rotations. The only control known is the use of resistant varieties. A resistant strain of Dwarf Yellow milo has been developed.

INSECT PESTS³

In addition to the sorghum midge (fig. 29), which attacks sorghums and Johnson grass, many insect pests common to Indian corn also attack the grain sorghums. Among the more important of these are the corn earworm, common stalk borers, webworms, the armyworm, sorghum webworm, green bug, corn leaf aphid, chinch bug (fig. 30), white grubs, and leafhoppers. The control of these pests on grain sorghums is, for the most part, similar to the control of such insects on Indian corn; however, control measures will differ somewhat because of variations in cultural practices and more particularly because of variations in the time and method of harvest. Information is usually available regarding the biology and control of most of these insect pests, and although the damage caused by various species may look the same, the control measures are usually different.

When injury is observed and information desired, specimens of the insects causing the damage, together with a sample of the injured plant, should be sent either to the State experiment station or

³ Prepared by W. H. Larrimer. Bureau of Entomology and Plant Quarantine, U. S. Department of Agriculture.

to the Bureau of Entomology and Plant Quarantine, United States Department of Agriculture, Washington, D. C.

USES OF GRAIN SORGHUMS

Millions of people in Africa, India, and China use grain sorghums in various forms for food. Meal made from grain sorghums can be used very much as corn meal is used in this country for por-

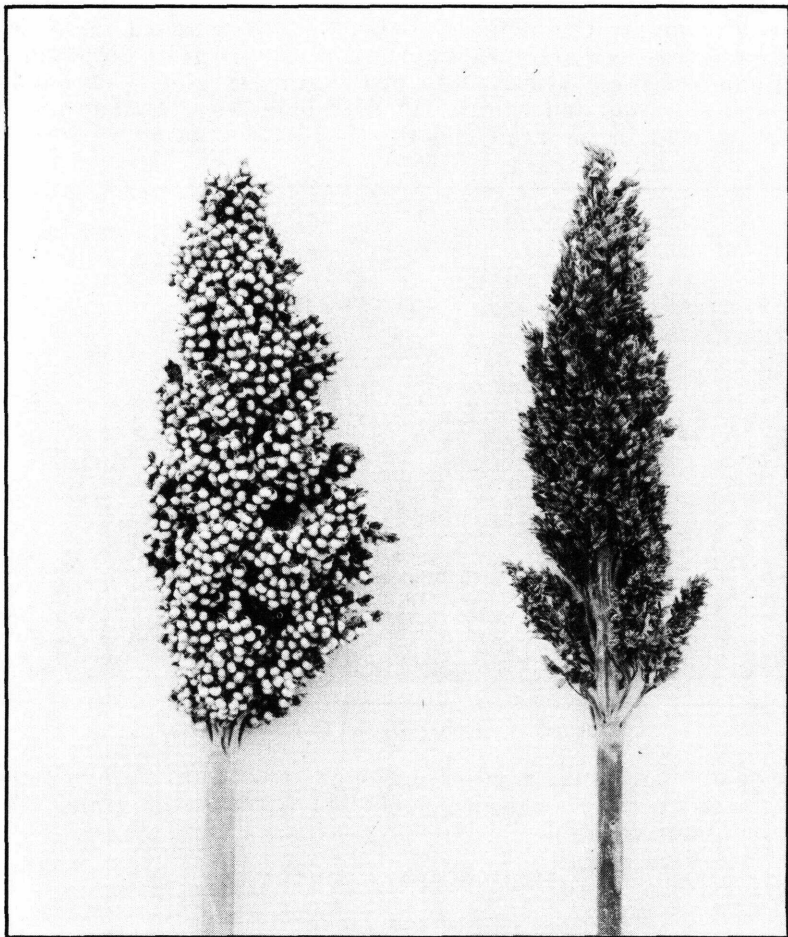


FIGURE 29.—Normal head of feterita and one injured by sorghum midge.

ridges, coarse breads, and battercakes. During the early settlement of the southern Great Plains kafir was frequently used as food by impoverished farm families who had produced very little else during years of short crops. At the present time, however, very little grain sorghum is used for human food in the United States; it is used almost entirely for livestock feed. Like other cereal grains, it can be used in the manufacture of alcohol and alcoholic drinks but is not so used in this country to any extent.

In China and Manchuria kaoliang stalks are used for fuel and for making baskets, mats, fences, shelters, furniture, and many other articles.

About 20 to 40 percent of the grain sorghum acreage in the United States is harvested for forage. Of the remainder which is harvested for the grain at least 75 or 80 percent is fed on the farms on which it is grown or in the immediate vicinity. About 10 million bushels or more are shipped to market annually. Much of this is used in mixed poultry and stock feeds to add variety to and improve the appearance of the ingredients in these mixed feeds, or to lower the total cost. Considerable quantities of grain sorghum are sold unmixed for poultry. Most of the grain sorghums are handled through elevators and shipped in bulk like other small grain, but some are sold in the head and threshed at the elevators before or

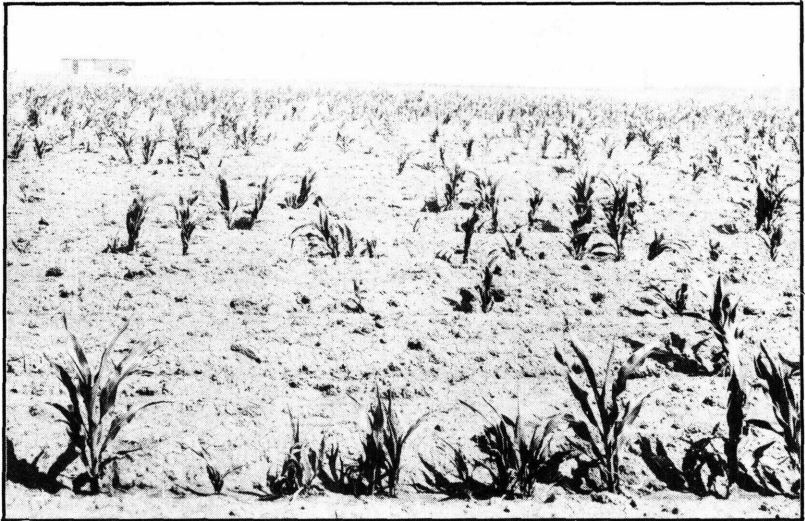


FIGURE 30.—Kafir destroyed by chinch bugs.

after shipping, or the heads are ground into chops. The standard test weight per bushel is 56 pounds, but much of the grain is sold by the hundredweight.

FEEDING GRAIN SORGHUMS

FEEDING VALUE

The profitable disposal of the grain sorghums produced in the semiarid sections of the United States depends largely upon feeding them to livestock on the farms where they are produced. Marketing the crops in the form of beef, pork, mutton, milk, or poultry increases the opportunity of the producer for a favorable financial outcome. Feeding the crops also utilizes both the grain and the roughage and makes manure available for maintaining soil fertility.

These crops are to the Great Plains region what corn is to the Corn Belt. The whole plant may be fed, either green, cured, or

ensiled. Unthreshed sorghum heads may be fed whole or ground or they may be threshed and the grain fed separately. The grain sorghums have less feeding value than corn, but the fact that they are heavy yielders in semiarid sections where corn fails, more than compensates for the small difference in feeding value.

Analyses of grain sorghums indicate that they are very similar to corn in composition. Corn, however, contains more fat, while sorghums contain more protein. The amounts of carbohydrates in the two are practically equal. Table 1 shows the chemical analyses of several varieties of grain sorghums grown at Amarillo, Tex. The average of many analyses of corn is given for comparison.

TABLE 1.—Analyses¹ of air-dry samples of grain sorghums grown at the Amarillo Cereal Field Station, Amarillo, Tex., 1908 to 1912, inclusive, compared with analyses of dent corn

Feed	Analyses made	Water	Ash	Crude protein	Crude fiber	Nitrogen-free extract (starch and sugar)	Ether extract (fat)	Kernels per pound	Weight per bushel
	Number	Percent	Percent	Percent	Percent	Percent	Percent	Number	Pounds
Milo.....	122	9.3	1.6	12.4	1.5	72.0	3.2	13,300	58.1
Feterita.....	8	9.6	1.7	14.0	1.5	70.3	2.9	14,100	55.9
Kafir.....	128	9.6	1.8	13.4	1.5	70.3	3.3	22,600	58.2
Shallu ²	10	10.4	2.0	15.2	1.9	65.9	3.7	30,000	57.9
Average of all varieties.....	268	9.5	1.7	13.0	1.5	70.9	3.3	17,100	58.1
Dent corn ³	1,294	12.9	1.3	9.3	1.9	70.3	4.3		

¹Analyses made by the Plant Chemical Laboratory of the Bureau of Chemistry and Soils, U. S. Department of Agriculture.

²Grown only in 1911 and 1912.

³Compiled by the Bureau of Chemistry and Soils, U. S. Department of Agriculture.

The amount of digestible nutrients which grain sorghums contain concerns the feeder more than does the composition, as they are the compounds which are assimilated and used to produce heat, energy, fat, milk, muscle, and bone. Table 2 compares the digestible nutrients in 100 pounds of 3 grain sorghums and shelled dent corn.

TABLE 2.—Digestible nutrients in 100 pounds of feed

Feed	Dry matter	Digestible nutrients		Nutritive ratio
		Crude protein	Total digestible nutrients	
	Pounds	Pounds	Pounds	
Feterita.....	90.9	10.8	80.2	1:7.4
Kafir.....	90.5	9.9	78.7	1:7.9
Milo.....	90.7	8.1	80.6	1:8.9
Dent corn.....	87.1	7.1	81.9	1:10.5

There appears to be little difference in the feeding value of different grain sorghums. The brown-seeded varieties, darso and Schrock, are somewhat unpalatable owing to a bitter taste and, when eaten less freely as is usually the case, produce lower daily gains than are produced when white, yellow, or red grain sorghums

are fed. In mixed rations, however, the gains made by animals fed darso have been nearly equal to those made by animals fed other grain sorghums.

Closely related to the grain sorghums are the sorgos. They produce a palatable hay or fodder much relished by stock and possessing about the same value as prairie hay. The seeds of sorgo, with the exception of the Atlas variety, are much less palatable and nutritious than those of the grain sorghums.

Some prejudice has existed as to the value of sorgo for silage, chiefly because of the belief that it is highly acid. However, experiments as well as the experience of practical farmers show that sorgo silage is a good cattle feed, especially when a little dry roughage and a high-protein meal are fed with it.

The grain sorghums may be utilized as forage in the form of stover and fodder, or they may be put into silos. For these purposes they compare favorably with corn. In the feeding of grain sorghum fodder in bundles, commonly called "bundle feed", the grain may vary from practically none to nearly a third of the dry weight, depending on the season and cultural conditions. Well-cured stover and fodder are well-liked by cattle, horses, and sheep, and in some sections are practically the sole roughage fed during the winter. Cattle can be wintered well on grain sorghum stover (fodder from which heads have been removed) with a small allowance of some feed rich in protein. Young stock should be fed more of the protein feed and possibly some grain in addition.

GRAIN SORGHUM SILAGE

As with corn, silage is often the most economical form in which the grain sorghum crops may be utilized, especially as winter feed for sheep and cattle. On an acre basis, kafir silage produced 63 percent more gain in wintering beef cattle at the Fort Hays (Kans.) Branch Station than ground kafir fodder. When cut at the proper stage, i. e., when the seeds are in the stiff-dough stage, grain sorghum silage has a feeding value practically equal to that of corn silage. Silage is particularly useful in the ration of cattle as an aid in keeping the body in proper tone and increasing the appetite. The quantity that can be fed varies from a few pounds a day to a calf, up to 40 to 50 pounds or even more to a dairy cow or a heavy steer.

Silage⁴ should be fed with a liberal addition of concentrates to fattening cattle and sheep, and to cows producing a heavy flow of milk. It contains so much water and crude fiber (though not so much of the latter as field-cured stover) that stock can eat and digest scarcely enough of it to supply their requirements for maintenance. Its use to supply the bulk of nutrients in a ration is chiefly in wintering beef breeding cows and stockers. In most cases some feed rich in protein should be fed with it, especially to calves and breeding cows.

Cattle, sheep, horses, mules, hogs, and poultry relish and do very well on grain sorghums (figs. 31 and 32).

⁴ See U. S. Dept. Agr. Farmers' Bulletin No. 578 for detailed information concerning the making and feeding of silage.

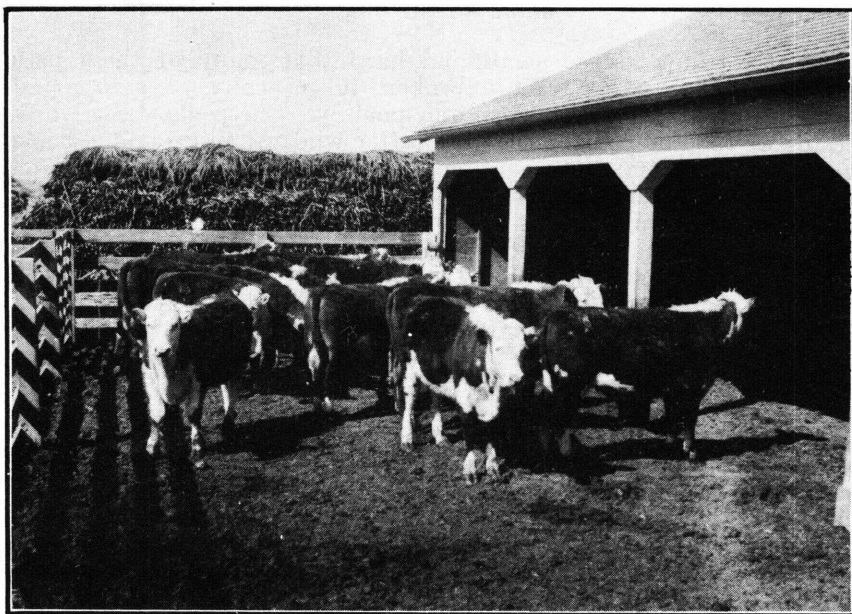


FIGURE 31.—Purebred cows in the Texas Panhandle wintered on kafir stover and a little grain.



FIGURE 32.—Fattening hogs on milo by means of a self-feeder.

GRINDING THE GRAIN

As the grains are so small and hard that many of them pass through the digestive tract unbroken, it generally pays to grind them for all stock except sheep and poultry. Sheep chew the whole grains well. For poultry they are better whole than ground. Some commercial poultry feeds contain a considerable proportion of sorghum grains. For other stock, grinding increases the palatability. Very often the entire heads are ground. The resulting meal, called head chop, is similar to corn-and-cob meal in food value and is recommended especially when the supply of roughage is limited. Ordinarily about 70 percent of the weight of the heads is grain. A summary of several experiments conducted by the Texas Agricultural Experiment Station shows that the ground heads of grain sorghums have about 87 percent as much value pound for pound as the ground grain. Kafir, milo, and hegari and probably others of the grain sorghums may be used in rations for hens and for young chickens in place of part or all of the yellow corn. The grain sorghums contain very little vitamin A, whereas yellow corn is a good source of this vitamin. If all or a large part of the yellow corn commonly recommended for poultry rations is replaced with grain sorghums, additional vitamin A should be furnished by supplying plenty of green feed by feeding 1 percent of cod-liver oil or 5 to 7 percent of alfalfa leaf meal in the mash.

The quantities to be fed depend on many factors, such as the quantity and kind of roughage, and of other concentrates available; the age, type, size, and kind of animal, and the purpose for which the stock is being fed. Suggested rations for various classes of livestock are given on page 44.

GRINDING THE FODDER

The principal advantage of grinding the fodder is in cracking the grains. The Kansas Agricultural Experiment Station secured 27 percent more gain on cattle wintered on ground-kafir fodder than on those wintered on whole-kafir fodder. It should be more economical to cut off the heads, feed the stover whole, and grind the heads.

Chopping the fodder usually does not pay because most of the grain remains whole. The stover, which contains no grain, should be fed whole. Stock will eat the best part of the stover, which constitutes one-half to two-thirds of its weight. The coarse parts which are refused are so low in feeding value that it usually does not pay to grind or chop them.

PASTURING GRAIN SORGHUMS

Sometimes stock are killed by grazing on sorgo and grain sorghum, particularly on stunted or second-growth plants. Stunting may be caused by extreme drought or other adverse conditions. At such stages of growth prussic acid, a deadly poison, sometimes accumulates in the plant tissue. When eaten by livestock in sufficient amounts, it causes poisoning, which is usually fatal. As the plants have this poisonous property only under certain conditions, losses may be largely avoided by using care and not turning the stock on

wilted, stunted, or frosted sorghums, especially when they are very hungry. No losses have been reported from poisoning in feeding the grain, heads, silage, hay, fodder, or stover of the grain sorghums.

Some feeders have found that the sorghum grains, if fed heavily, constipate stock. To counteract this, it is better to feed with sorghums some laxative feed, such as linseed meal, bran, soybeans, or alfalfa hay. Moldy grain-sorghum feeds should be avoided as much as possible, as there is usually danger of disorders in using moldy feeds. Moldy sorghum is especially dangerous for horses and probably should not be used as a horse feed.

RATIONS INCLUDING GRAIN SORGHUMS

The feeder should always remember that grain sorghums alone do not form a satisfactory ration for growing animals. The proper growth of the young and the economical production of milk and eggs are impossible when there are not sufficient protein, minerals, and vitamins in the ration. Feeds that are rich in such nutrients must be given for favorable results. Legume hay, milk, the cakes and meals produced in extracting oil from seeds, and packing-house and fishery byproducts are excellent sources of the necessary protein and ash. When sufficient alfalfa, clover, or other legume hay is used, protein-rich concentrates are not necessary. Otherwise the ration should be balanced by adding some feed, such as cottonseed meal or cake, linseed meal, soybean-oil meal, or peanut meal. Green and leafy hay and pasture are usually the most practical sources of vitamin A for farm animals.

Recent experiments have shown that small quantities of ground oyster shell or limestone can supply the necessary calcium, which usually is obtained from legume hay.

Whole cottonseed has been substituted satisfactorily for cottonseed meal as a source of additional protein in feeding experiments in which grain sorghums and sorghum roughage were used. Cotton is grown extensively in the southern half of the grain-sorghum region, and there livestock can be fattened entirely upon home-grown feeds if ground limestone is added to the ration. Legume hay, green pasture, or some other source of vitamin A is necessary in an extended feeding period.

While no standard combination of feeds can be given that will apply to all sections where grain sorghums are grown extensively, the following rations are suggested for various classes of livestock. They are intended chiefly to show the proportions of grain, protein-rich concentrate, silage, stover, straw, and hay to use.

In the fattening rations the proportion of roughage to concentrates should be much greater at the beginning of the feeding period than those shown in table 3. Animals should always be put on a full feed of concentrates gradually. Toward the close of the fattening process the quantities of grain should be increased gradually and the proportion of roughage lowered accordingly. Alfalfa may be replaced by other legume hays. If no such hay is available, it is advisable to use a protein-rich concentrate. Cottonseed meal may be replaced by linseed meal, soybean-oil meal, or peanut meal.

TABLE 3.—*Suggested rations containing grain sorghums*¹

WINTERING BEEF CATTLE		
Calves	Yearlings	2-year-olds and aged cattle
<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>
Kafir stover..... 4	Kafir stover..... 20	Kafir stover..... 30
Cottonseed cake..... 1	Cottonseed cake..... 2	Cottonseed cake..... 2
or	or	or
Kafir silage..... 12	Kafir silage..... 20	Kafir silage..... 30
Alfalfa hay..... 7	Alfalfa hay..... 6	Straw..... 8
		Alfalfa hay..... 3

FATTENING BEEF CATTLE		
Calves	Yearlings	2-year-olds
<i>200 days' feed</i> <i>Pounds</i>	<i>170 days' feed</i> <i>Pounds</i>	<i>130 days' feed</i> <i>Pounds</i>
Kafir head chop..... 13	Kafir head chop..... 16	Kafir head chop..... 18
Alfalfa hay..... 8	Alfalfa hay..... 7	Alfalfa hay..... 9
or	or	or
Kafir silage..... 15	Kafir silage..... 15	Kafir head chop..... 15
Kafir chop..... 10	Kafir head chop..... 13	Cottonseed meal..... 2
Straw..... 2	Straw..... 4	Straw..... 5
Cottonseed meal..... 2	Cottonseed meal..... 2	Kafir silage..... 15

COWS		
Maintaining dry cows (weighing approximately 1,000 pounds)		Cows producing milk
<i>No. 1</i> <i>Pounds</i>	<i>No. 2</i> <i>Pounds</i>	To either of the maintenance rations add 1 pound of the following mixture for each 2 pounds of milk produced: Kafir head chop 300 pounds, and cottonseed meal 100 pounds.
Kafir stover..... 24	Kafir silage..... 35	
Alfalfa hay..... 7	Alfalfa hay..... 6	

HORSES DOING MODERATE WORK		
(Weighing approximately 1,250 pounds)		
<i>No. 1</i> <i>Pounds</i>	<i>No. 2</i> <i>Pounds</i>	
Kafir chop..... 14	Kafir head chop..... 12	
Alfalfa hay..... 7	Alfalfa hay..... 7	
Sudan hay..... 7	Cottonseed meal..... 1	
	Kafir stover..... 14	

SHEEP		
Lambs		Breeding sheep (Weighing about 125 pounds)
<i>No. 1</i> <i>Pounds</i>	<i>No. 2</i> <i>Pounds</i>	<i>Pounds</i>
Kafir grain..... 1.0	Kafir grain..... 1.2	Kafir stover..... 3.0
Cottonseed meal..... .2	Alfalfa hay..... 1.5	Alfalfa hay..... 2.0
Kafir stover..... 3.0		

¹ The quantities of stover suggested are based on the stock eating one-half to two-thirds of the quantities of whole stover included in the rations.

TABLE 3.—*Suggested rations containing grain sorghums—Continued*
CHICKENS ²

<i>Scratch mixture for laying or growing pullets</i>	<i>Parts by weight</i>	<i>Mash for growing chickens</i>	<i>Parts by weight</i>	<i>Mash for laying hens</i>	<i>Parts by weight</i>
Sorghum grains.....	2	Ground sorghum grains.....	20	Ground sorghum grains.....	20
Yellow corn.....	1	Yellow corn meal.....	20	Yellow corn meal.....	20
Wheat, oats, or barley.....	1	Wheat bran.....	15	Meat meal.....	20
		Wheat middlings or ground wheat.....	12	Wheat middlings or ground wheat.....	12
		Finely ground oats.....	10	Ground oats or barley.....	10
		Meat meal.....	10	Wheat bran or ground wheat.....	10
		Dried milk.....	5	Alfalfa leaf meal.....	7
		Alfalfa leaf meal.....	5	Ground limestone.....	2
		Ground limestone.....	2	Salt.....	1
		Salt.....	1		

² Many rations for chickens contain some source of vitamin D such as 0.5 to 2 percent of cod-liver or sardine oil. This is particularly important in the case of chickens that are closely confined.

Similar quantities of milo, hegari, or feterita grain may be substituted for the kafir listed in the suggested rations. Similar quantities of hegari or feterita stover or silage may be substituted for the kafir stover or silage. Feterita produces a less desirable forage, however, than kafir or hegari. Milo stover is not commonly harvested for feed. Other roughages also, such as Sumac (Red Top), Honey, Atlas, or Orange sorgo (cane) may be substituted for kafir.

A mineral mixture, such as equal parts of steamed bonemeal, finely ground limestone, and common salt, should be kept where the stock can get it readily.

For fattening hogs and sows with suckling pigs, kafir chops and tankage should be fed in separate compartments of a self-feeder in addition to all the high-grade legume hay, preferably alfalfa, or good pasture that they will eat.

For brood sows during the gestation period a satisfactory ration may be made by using 1½ pounds of kafir chops for each 100 pounds of weight and approximately one-third of a pound of tankage per head daily, provided they have access to all the high-grade alfalfa hay or good pasture that they will eat.

On farms where sufficient skim milk or buttermilk is available such feeds may replace tankage. For fattening hogs weighing under 150 pounds, one should feed about three times as much of such milk as the quantities of grain consumed to properly balance the ration. For hogs weighing over 150 pounds about twice as much milk as grain is sufficient. On good pasture, twice as much milk as grain for hogs under 150 pounds, and equal parts of grain and skim milk for hogs over 150 pounds will be sufficient. For brood sows, from two to three times as much milk as grain should be fed to balance the ration.

Hogs having plenty of good pasture (leafy and immature forage is richest in vitamins, minerals, proteins, and other digestible nutrients) or green and leafy legume hay and milk or tankage require little, if any, supplemental minerals other than common salt.

REQUIREMENTS FOR AND RETURNS FROM GROWING GRAIN SORGHUMS

The farm equipment necessary for growing grain sorghums is the same as for corn up to harvesttime.

In the eastern part of the grain sorghum region a typical method of growing grain sorghums includes plowing the land with a gang plow, followed by double-disking and harrowing. The seed is then planted with a two-row corn planter and the crop cultivated about two to four times with a one-row riding cultivator. If implements of the usual size are used and if all field operations are completed at a normal rate and allowance is made for double-disking and replanting a third of the acreage, there would be required about 8 to 9 hours of man labor and 30 hours of horse work per acre to grow the crop up to harvesttime.

In the western semiarid sections, where the grain sorghum crop is grown by the lister method, a common procedure is to list the land in the spring, break the ridges, and plant, all three operations being performed with two-row implements. After the crop has come up, the furrows are thrown out and are later thrown in with two-row lister cultivators, probably with a harrowing between the cultivations. By following these methods and allowing for replanting a third of the acreage, about 4 hours of man labor and 8 hours of horse work are usually required to bring the crop to maturity. The use of tractor machinery and larger units will reduce the necessary man labor per acre considerably in either the eastern or western sections.

The labor items involved in harvesting grain sorghums vary somewhat with the methods used and are discussed on page 30.

The quantity of seed used for a single planting varies considerably but is usually between 2 and 4 pounds an acre. Replanting, of course, increases the seed requirements. The cost or value of the seed varies from 1 to 5 cents per pound. Chemical dust for seed treatment should not cost more than 1 cent per acre, and the labor and equipment required for seed treatment are small.

The average yield of grain sorghums in this country is about 16 bushels per acre. Yields below the average result usually from deficient moisture, early frosts, thin stands, insufficient cultivation, insect injury, and diseases. Under favorable conditions in the Great Plains, grain sorghums will yield from 25 to 60 bushels an acre, and milo grown under irrigation in the Southwest often produces much higher yields. The price of grain sorghum is usually slightly less than that of corn in the southern Great Plains, where most of the surplus grain is produced.